

# SSME ALTERNATE TURBOPUMP DEVELOPMENT PROGRAM (HPOTP)

## VERIFICATION COMPLETE REPORT THIRD TURBINE BLADE AERODYNAMIC DESIGN DVS DR NO. 3.1.2.2.5.1, VM NO. 4.1.2.4 A

JUNE 1989

Prepared under  
NASA Contract NAS8-36801  
DRL Sequence No. SE12  
WBS No. 1.5.1.2

Prepared for  
George C. Marshall Space Flight Center  
National Aeronautics and Space Administration  
Marshall Space Flight Center, AL 35812

Prepared by  
Pratt & Whitney  
P. O. Box 109600  
West Palm Beach, FL 33410-9600

Approved by:

*John Price Jr.*  
W. C. Shubert  
ATD Project Manager

(NASA-CR-183750) SSME ALTERNATE TURBOPUMP  
DEVELOPMENT PROGRAM (HPOTP). VERIFICATION  
COMPLETE REPORT. THIRD TURBINE BLADE  
AERODYNAMIC DESIGN DVS DR NO. 3.1.2.2.5.1,  
VM NO. 4.1.2.4 A (Pratt and Whitney)

N89-71572

Unclassified  
00/20 0233361



**UNITED  
TECHNOLOGIES  
PRATT&WHITNEY**

### HPOTP Turbine Aerodynamic Design

The High Pressure Oxidizer Turbopump (HPOTP) turbine aerodynamic design is based on the requirements defined by the Interface Control Document (ICD) and by the Power Balance Model, Table 387B. Performance Table 387B was used for the turbine aerodynamic design because its turbine flow capacities are consistent with the baseline turbine nozzle flow test results conducted on Pratt & Whitney's test stand, E-6, in December, 1986.

A 3-stage turbine was selected over a 2-stage design for three basic reasons:

1. To retain desired efficiency at the reduced pump speeds.
2. To provide adequate performance margin with unshrouded blades.
3. To ensure adequate margins for adjusting to cycle requirements.

A conventional pressure-compounded, 3-stage design was chosen because of its inherent high efficiency with low aerodynamic risk. This aerodynamic advantage allowed the use of unshrouded blades. Unshrouded blades are desirable because they permit the use of PW1480 single-crystal material, which provides superior thermal fatigue characteristics, but at the present state-of-the-art, cannot be easily cast in the form of shrouded blades in this small size. The turbine aerodynamic design provides relatively high velocity ratios, which are within the range of normal design practice and experience. Avoiding lower velocity ratios eliminates excessive gas turning, and the need for blades with excessively small leading edge radii. Blades with sharp leading edges make the turbine intolerant at incidence angle changes resulting from off-design operation. Under such conditions, severe flow separation is common.

The methodology associated with the design of the HPOTP starts with the meanline design analysis. This analysis is based on the assumption that the flow through the turbine can be represented by the flow at the center of the flow passage. This simplified approach permits selection of the number of stages required, the mean diameter of the flow passage, and the annulus area. Included in the analysis is an estimate of the aerodynamic efficiency. This prediction system uses the physical laws of aerodynamics and correlations from rig and engine data to estimate profile loss, secondary loss, blade tip leakage, and shock and incidence losses based on the geometry and aerodynamic parameters of the turbine. An interactive graphic flowpath design system is used, in conjunction with the optimum meanline design, to generate candidate flowpath configurations.

The streamline design analysis is used to optimize the radial variation in the velocity triangles, once the average conditions are selected from the meanline analysis. This analysis calculates the flow characteristics at numerous radial locations and at the inlet and exit of each airfoil row. Once the meanline and streamline analyses have been used to optimize the velocity triangles throughout the turbine, 2 dimensional (2-D) airfoil sections are designed. These airfoil sections are designed to achieve contours that provide the desired amount of flow turning without permitting the flow to separate from

the airfoil surface. This process involves determining the static pressure distributions and boundary layer parameters along the airfoil surfaces and endwalls. An interactive graphics airfoil design system is used to identify adverse static pressure gradients such that the airfoil contour can be modified appropriately. After the 2-D airfoils are estimated at several spanwise locations, they are radially faired and combined with a preliminary endwall definition. An inviscid multi-stage 3-D flow analysis is then used to refine and optimize the entire flowpath configuration.

All turbine airfoil, endwall, inlet, and exit flow passage surfaces are contoured and refined as a system. The multi-stage feature enables a complete evaluation of potential changes to an individual surface contour during the design process. This assessment includes, not only flow property changes around the component being modified, but also around all upstream and downstream components in the complete turbine system. Improved performance and reduced risk result from this global optimization capability.

This report contains:

- o Hot elevation diagrams for each airfoil
- o 3-D airfoil plots
- o 2-D airfoil section plots
- o Tabulated airfoil section coordinates
- o A plot of hot gaging dimensions versus radius
- o A plot of percent change in flow area versus airfoil rotation
- o A plot of stress versus span
- o 3-D airfoil static pressure distributions
- o Airfoil Ps/PT and Mach number contours
- o A plot of suction surface boundary layer friction coefficient versus surface distance

COVER SHEET  
SPACE SHUTTLE  
ENGINE A.T.P. LOX PUMP TURBINE  
AIRFOIL 3RD STAGE BLADE  
ENGINEER BRANSTROM EXT 2824 DATE 6/24/87

AERODYNAMIC DESIGN POINT 109% POWER - DES. TABLE 0387.B DATED 4/10/87

F.T.D. LIST:

ELEVATION \_\_\_\_\_

AIRFOIL SECTIONS \_\_\_\_\_

AIRFOIL COORDINATES \_\_\_\_\_

DF LIST:

GAGING VS. RADIUS \_\_\_\_\_

FLOW AREA VS. ROTATION \_\_\_\_\_

STRESS VS. % SPAN \_\_\_\_\_

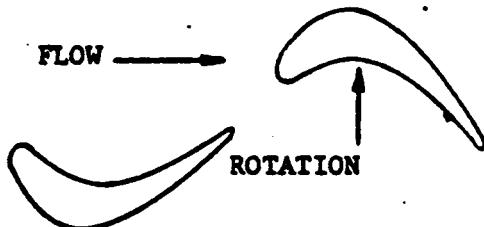
PRESSURE DIST. \_\_\_\_\_

BOUNDARY LAYER \_\_\_\_\_ N.A.

CHECK ONE

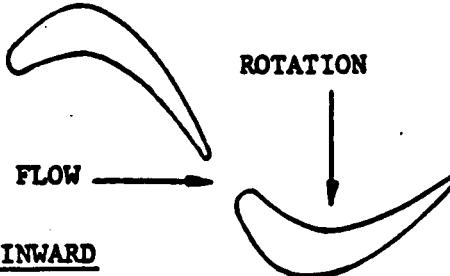
P&WA CONVENTIONAL ROTATION

VANE \_\_\_\_\_ BLADE \_\_\_\_\_



P&WA COUNTER ROTATION ✓

VANE \_\_\_\_\_ BLADE ✓



VIEW LOOKING RADIALLY INWARD

A.T.D. OXIDIZER PUMP TURBINE

3<sup>rd</sup> STAGE BLADE

AIRFOIL IS CIRCLE LINE FAIRED BETWEEN DEFINING SECTIONS  
OVERALL ELEVATION IS AT FOCUS OF FLOW

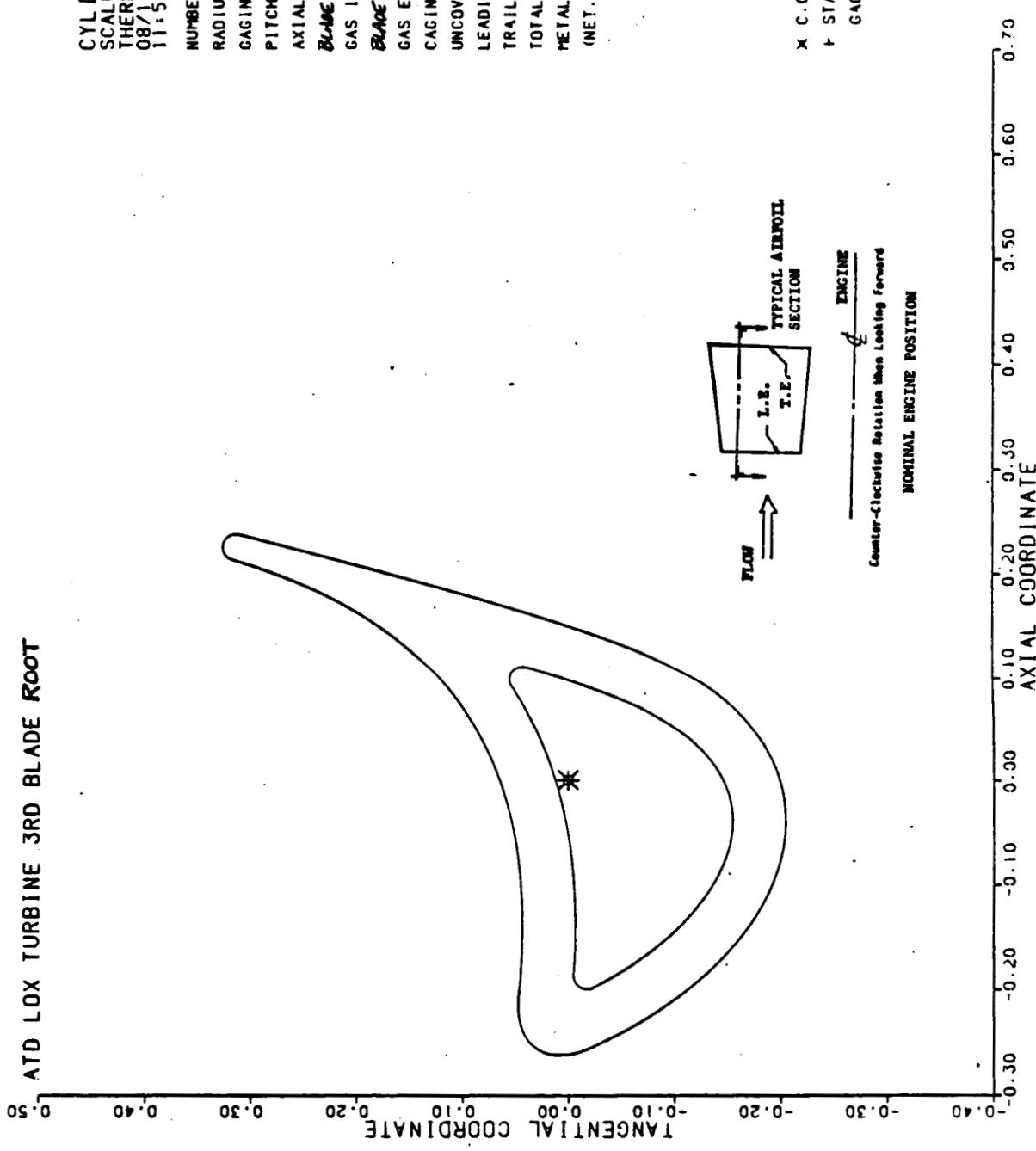
ALL DIMENSIONS ARE INCHES

TIP DIAMETER 5.60

0.0160"

TIP 5.530 -	357	5.530 R	3.115	5.50
		BLADE TIP		
			5.5464"	5.40
			CASE	
1/4 TIP 5.322 -				5.30
MEAN 5.115 -				5.20
1/4 ROOT 4.907 -		54 BLADES		5.10
ROOT 4.700 -	4.70	67305 # DULL (GRIND)		5.00
DEFINING SECTION 3.25	3.25	(47500 RPM)		4.90
\$ EXONES 3.6 3.5 3.4 3.3 3.2 3.1 3.0		0.30" RAD. MATE DESIGN		4.80
				4.70
		DISTANCE FROM 1 <sup>st</sup> VANELE. INCHES		
				7/1/87
				BB

ATD LOX TURBINE 3RD BLADE Root



CYLINDRICAL  
SCALE 10.0  
THERMAL SHRINK FACTOR 1.000000  
08/17/87  
11:55:59

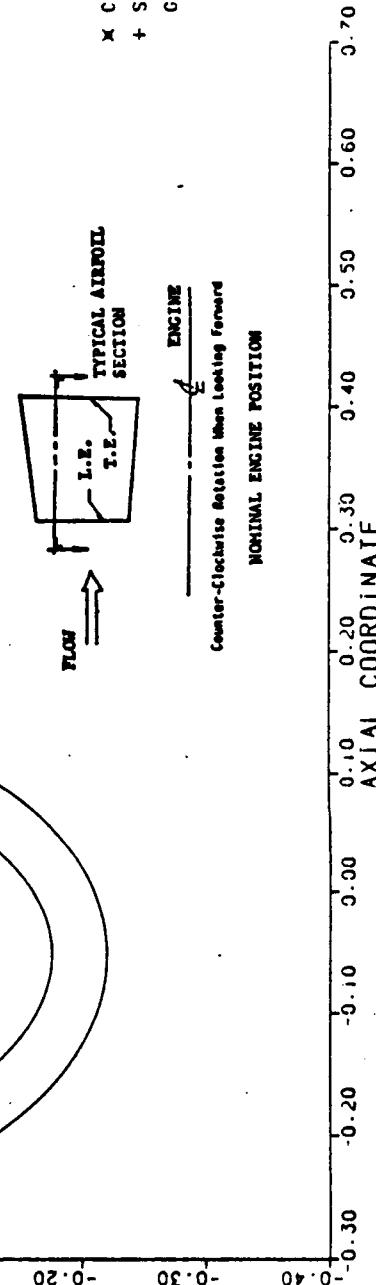
NUMBER OF BLADES	54.
RADIUS (HOT)	4.700 INCHES
GAGING (HOT)	0.1563 INCHES
PITCH (HOT)	0.5469 INCHES
AXIAL WIDTH	0.4987 INCHES
BLADE INLET ANGLE	54.0 DEGREES
GAS INLET ANGLE	24.50 DEGREES
BLADE EXIT ANGLE	15.606 DEGREES
GAS EXIT ANGLE	15.606 DEGREES
CAGING ANGLE	16.607 DEGREES
UNCOVERED TURNING	21.741 DEGREES
LEADING EDGE RADIUS	0.0153 INCHES
TRAILING EDGE RADIUS	0.0125 INCHES
TOTAL AREA (SOLID)	0.0983 SQ. IN.
METAL AREA	0.0624 SQ. IN. (NET, UNCOATED)

AIAA LOX TURBINE 3RD BLADE 1/4 ROOT

CYLINDRICAL  
 SCALE 10.0  
 THERMAL SHRINK FACTOR 1.000000  
 08/17/87  
 11:55:59

NUMBER OF BLADES	54.
RADIUS (HOT)	4.907 INCHES
GAGING (HOT)	0.1793 INCHES
PITCH (HOT)	0.5710 INCHES
AXIAL WIDTH	0.4887 INCHES
BLADE INLET ANGLE	47.0 DEGREES
GAS INLET ANGLE	- 36.57 DEGREES
BLADE EXIT ANGLE	17.607 DEGREES
GAS EXIT ANGLE	17.607 DEGREES
GAGING ANGLE	18.304 DEGREES
UNCOVERED TURNING	22.019 DEGREES
LEADING EDGE RADIUS	0.0174 INCHES
TRAILING EDGE RADIUS	0.0125 INCHES
TOTAL AREA (SOLID)	0.0323 SQ. IN.
METAL AREA	- 0.0376 SQ. IN. (WET. UNCOATED)

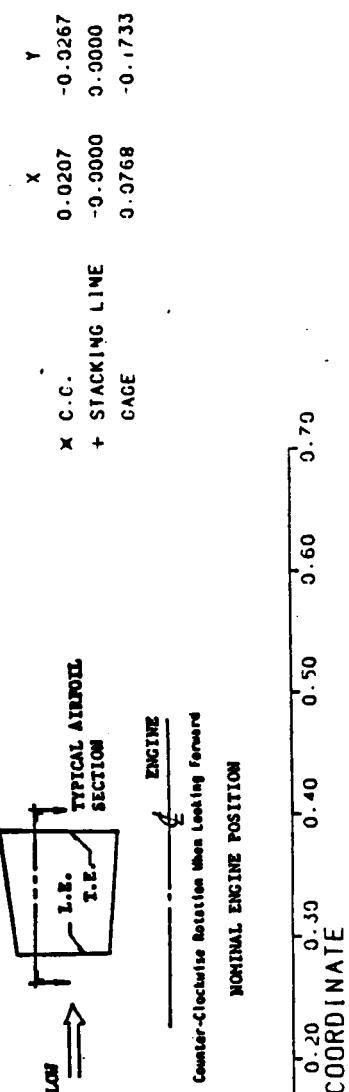
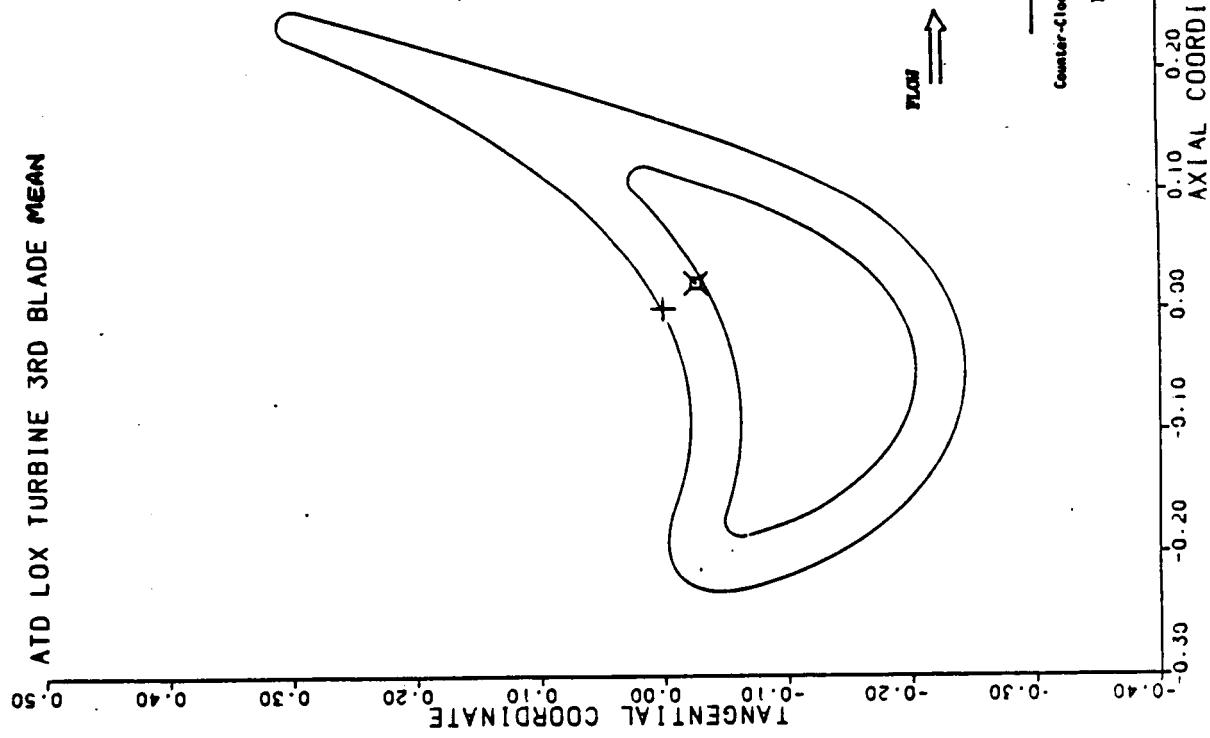
TANGENTIAL COORDINATE



ATD LOX TURBINE 3RD BLADE MEAN

CYLINDRICAL  
SCALE 10.0  
THERMAL SHRINK FACTOR 1.000000  
08/17/87  
11:55:59

NUMBER OF BLADES	54.
RADIUS (HOT)	5.115 INCHES
GAGING (HOT)	0.1877 INCHES
PITCH (HOT)	0.5952 INCHES
AXIAL WIDTH	0.4786 INCHES
BLADE INLET ANGLE	42.0 DEGREES
GAS INLET ANGLE	27.60 DEGREES
BLADE EXIT ANGLE	18.564 DEGREES
GAS EXIT ANGLE	18.564 DEGREES
GAGING ANGLE	18.383 DEGREES
UNCOVERED TURNING	22.340 DEGREES
LEADING EDGE RADIUS	0.0175 INCHES
TRAILING EDGE RADIUS	0.0125 INCHES
TOTAL AREA (SOLID)	0.0882 SQ. IN.
METAL AREA	0.0533 SQ. IN.
(NET, UNCOATED)	



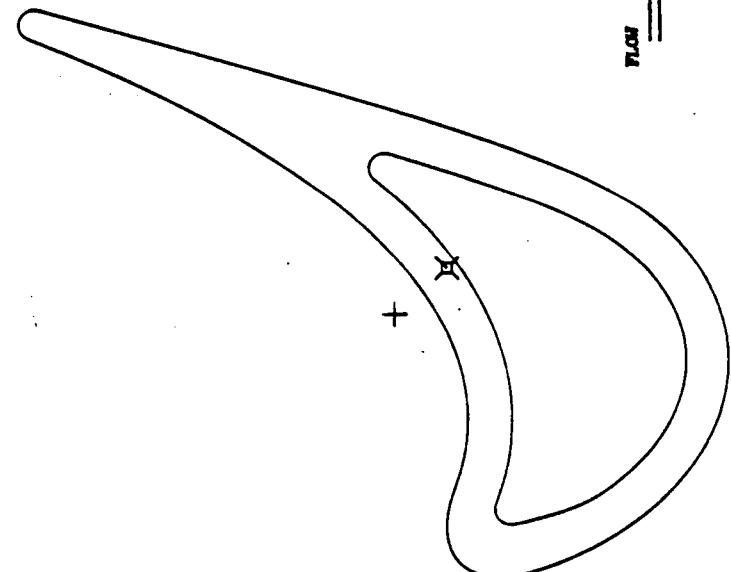
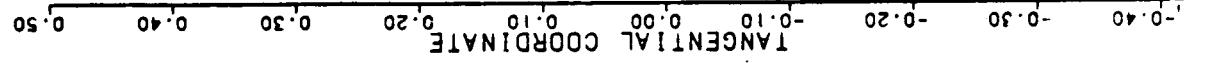
ATD LOX TURBINE 3RD BLADE 1/4 TIP

CYLINDRICAL  
SCALE 10.0

THERMAL SHRINK FACTOR 1.000000  
08/17/87

11:55:59

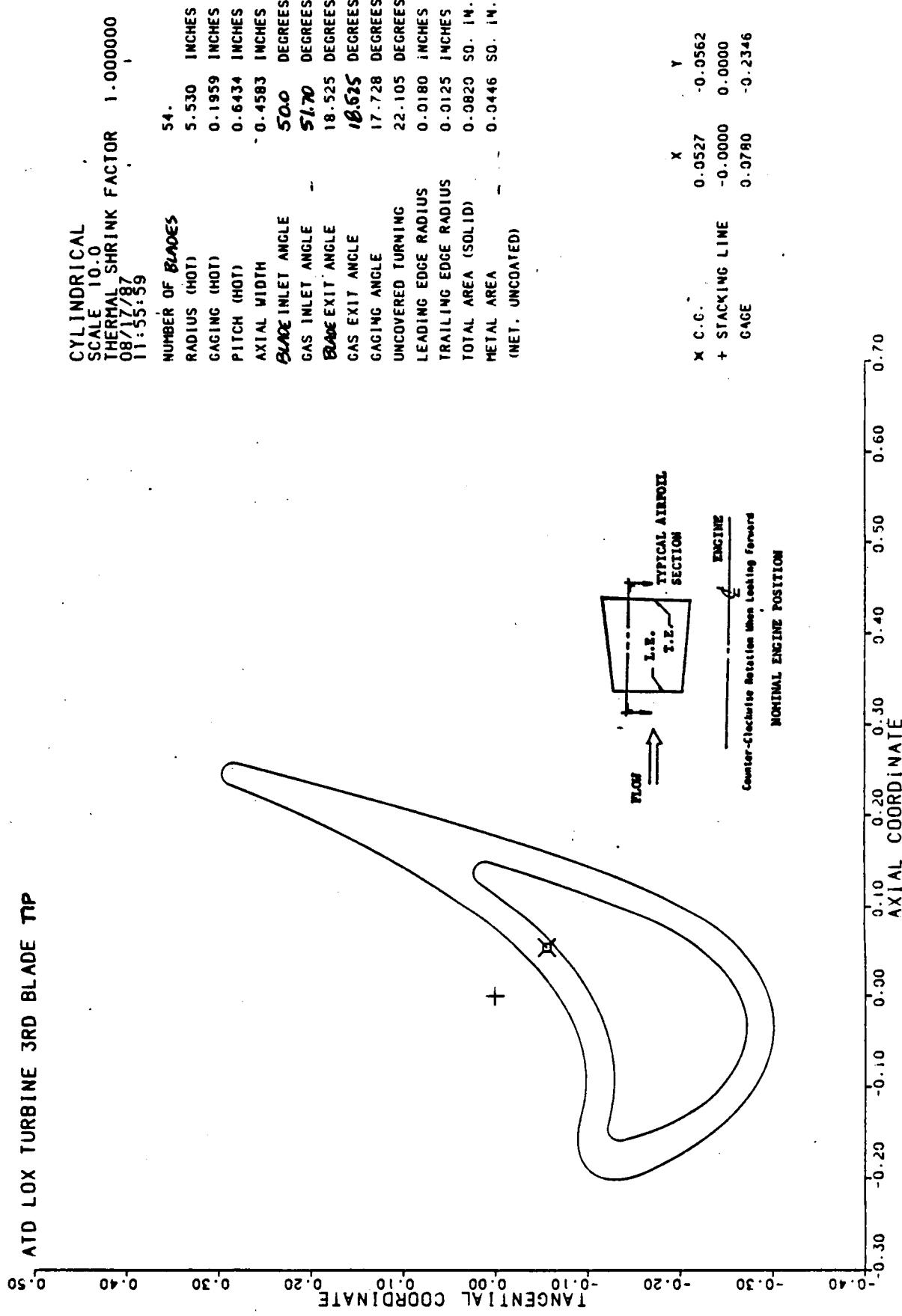
NUMBER OF BLADES	54.
RADIUS (HOT)	5.322 INCHES
GAGING (HOT)	0.1874 INCHES
PITCH (HOT)	0.6192 INCHES
AXIAL WIDTH	0.4685 INCHES
BLADE INLET ANGLE	43.0 DEGREES
GAS INLET ANGLE	34.21 DEGREES
BLADE EXIT ANGLE	18.592 DEGREES
GAS EXIT ANGLE	18.592 DEGREES
GAGING ANGLE	17.618 DEGREES
UNCOVERED TURNING	22.467 DEGREES
LEADING EDGE RADIUS	0.0211 INCHES
TRAILING EDGE RADIUS	0.0125 INCHES
TOTAL AREA (SOLID)	0.0856 SQ. IN.
METAL AREA	0.0491 SQ. IN. (NET. UNCOATED)



Centerline Relative Motion when Looking forward  
NOMINAL ENGINE POSITION



ATD LOX TURBINE 3RD BLADE TIP



EXTERNAL CURVATURE  
TD SUBTITLE

1 TD REV. 1 PART NO. END NO.

TITLE - SATP LOX TURBINE 3RD BLADE

COLD RADIUS = 4.700000

DATE 06/24/87 TIME 13:24:26 CYLINDRICAL

Thermal Shrink Factor = 1.000000

PRETMIST NOT USED FOR TD PRINTOUT.

PCT X	X TOP	Y TOP	(CIRCLE)	X BOT	Y BOT	(CIRCLE)
0.0	-0.26194	-0.00826	-0.00872	-0.26194	-0.00828	-0.00879
0.010	-0.25695	0.01604		-0.25695	-0.02641	
0.020	-0.25196	0.02753		-0.25196	-0.03497	
0.030	-0.24698	0.03791		-0.24698	-0.03903	
0.040	-0.24199	0.04770		-0.24199	-0.04124	
0.050	-0.23700	0.05692		-0.23700	-0.04603	
0.060	-0.23201	0.06566		-0.23201	-0.04552	
0.070	-0.22703	0.07396		-0.22703	-0.04552	
0.080	-0.22204	0.08183		-0.22204	-0.04714	
0.090	-0.21705	0.08933		-0.21705	-0.04741	
0.100	-0.21206	0.09647		-0.21206	-0.04740	
0.125	-0.19960	0.11292		-0.19960	-0.04642	
0.150	-0.16713	0.12758		-0.16713	-0.04536	
0.175	-0.17466	0.14064		-0.17466	-0.04551	
0.200	-0.16219	0.15225		-0.16219	-0.04590	
0.225	-0.14972	0.16255		-0.14972	-0.04593	
0.250	-0.13725	0.17161		-0.13725	-0.04343	
0.275	-0.12476	0.17950		-0.12478	-0.04360	
0.300	-0.11232	0.18625		-0.11232	-0.04406	
0.325	-0.09985	0.19193		-0.09985	-0.04402	
0.350	-0.08739	0.19655		-0.08739	-0.04591	
0.375	-0.07491	0.20112		-0.07491	-0.04734	
0.400	-0.06244	0.20264		-0.06244	-0.04914	
0.425	-0.04997	0.20411		-0.04997	-0.05134	
0.450	-0.03750	0.20452		-0.03750	-0.05395	
0.475	-0.02504	0.20394		-0.02504	-0.05701	
0.500	-0.01257	0.20203		-0.01257	-0.06056	
0.525	-0.00010	0.19904		-0.00010	-0.06444	
0.550	0.01237	0.19480		0.01237	-0.06929	
0.575	0.02484	0.18920		0.02484	-0.07454	
0.600	0.03731	0.18215		0.03731	-0.08048	
0.625	0.04978	0.17347		0.04978	-0.08715	
0.650	0.06224	0.16296		0.06224	-0.09464	
0.675	0.07471	0.15030		0.07471	-0.10301	
0.700	0.08718	0.13507		0.08718	-0.11240	
0.725	0.09965	0.11661		0.09965	-0.12292	
0.750	0.11212	0.09415		0.11212	-0.13471	
0.775	0.12459	0.06713		0.12459	-0.14798	
0.800	0.13706	0.03550		0.13706	-0.16293	
0.825	0.14952	-0.00030		0.14952	-0.17988	
0.850	0.16199	-0.03954		0.16199	-0.19921	
0.875	0.17446	-0.08141		0.17446	-0.22145	
0.900	0.18693	-0.12523		0.18693	-0.24735	
0.910	0.19192	-0.14319		0.19192	-0.25897	
0.920	0.19691	-0.16135		0.19691	-0.27145	
0.930	0.20189	-0.17969		0.20189	-0.28490	
0.940	0.20688	-0.19620		0.20688	-0.29447	
0.950	0.21187	-0.21685		0.21187	-0.31536	
0.960	0.21686	-0.23562		0.21686	-0.33281	-0.32337
0.970	0.22184	-0.25451		0.22184	-0.35216	-0.32559
0.980	0.22683	-0.27350		0.22683	-0.37390	-0.32558
0.990	0.23182	-0.29258		0.23182	-0.39873	-0.32332
1.000	0.23680	-0.31174	-0.31333	0.23680	-0.42771	-0.31333

NO. 1 CORE CONTOUR  
TD SUBTITLE 1 TD REV. 1 PART NO. END NO.  
TITLE - SATP LOK TURBINE 3RD BLADE  
COLD RADIUS = 4.700000

DATE 06/24/87 TIME 13:24:26  
CYLINDRICAL  
THERMAL SHRINK FACTOR = 1.000000

PRETMIST NOT USED FOR TD PRINTOUT.

PCT X	X TOP	Y TOP	(CIRCLE)	X BOT	Y BOT	(CIRCLE)
0.0	-0.19293	0.02016	0.01717	-0.19283	0.00359	0.01717
0.010	-0.19673	0.02619		-0.19673	0.00383	0.00893
0.020	-0.19363	0.03190		-0.19363	0.00408	0.00637
0.030	-0.19053	0.03754		-0.19053	0.00434	0.00509
0.040	-0.18743	0.04287		-0.18743	0.00461	0.00467
0.050	-0.18433	0.04799		-0.18433	0.00488	
0.060	-0.18123	0.05292		-0.18123	0.00513	
0.070	-0.17813	0.05766		-0.17813	0.00536	L.E. CIRCLE (X,Y,R)
0.080	-0.17503	0.06223		-0.17503	0.00558	I.E. CIRCLE (X,Y,R)
0.090	-0.17193	0.06664		-0.17193	0.00576	-0.18732 0.01717 0.01251
0.100	-0.16883	0.07090		-0.16883	0.00592	
0.125	-0.16109	0.08101		-0.16109	0.00622	L.E. BOTTOM TANG. PT. (X,Y)
0.150	-0.15334	0.09203		-0.15334	0.00641	L.E. TOP TANG. PT. (X,Y)
0.175	-0.14559	0.09867		-0.14559	0.00652	I.E. BOTTOM TANG. PT. (X,Y)
0.200	-0.13764	0.10671		-0.13784	0.00656	T.E. BOTTOM TANG. PT. (X,Y)
0.225	-0.13009	0.11390		-0.13009	0.00650	NOSE POINT (X,Y)
0.250	-0.12234	0.12046		-0.12234	0.00636	TAIL POINT (X,Y)
0.275	-0.11459	0.12642		-0.11459	0.00609	
0.300	-0.10684	0.13179		-0.10684	0.00573	-0.19770 0.01020
0.325	-0.09910	0.13660		-0.09910	0.00525	
0.350	-0.09135	0.14083		-0.09135	0.00466	
0.375	-0.08360	0.14452		-0.08360	0.00396	
0.400	-0.07585	0.14763		-0.07585	0.00314	
0.425	-0.06810	0.15019		-0.06810	0.00220	
0.450	-0.06035	0.15216		-0.06035	0.00113	
0.475	-0.05260	0.15356		-0.05260	0.00009	
0.500	-0.04485	0.15434		-0.04485	0.00143	
0.525	-0.03711	0.15451		-0.03711	0.00291	
0.550	-0.02936	0.15403		-0.02936	0.00454	
0.575	-0.02161	0.15286		-0.02161	0.0032	
0.600	-0.01386	0.15097		-0.01386	0.00825	
0.625	-0.00611	0.14834		-0.00611	0.01035	
0.650	0.00164	0.14490		0.00164	0.01263	
0.675	0.00939	0.14062		0.00939	0.01507	
0.700	0.01714	0.13545		0.01714	0.01770	
0.725	0.02489	0.12299		0.02489	0.02053	
0.750	0.03263	0.12206		0.03263	0.02354	
0.775	0.04038	0.11362		0.04038	0.02676	
0.800	0.04613	0.10379		0.04613	0.03021	
0.825	0.05586	0.09229		0.05586	0.03388	
0.850	0.06363	0.07697		0.06363	0.03776	
0.875	0.07136	0.06363		0.07136	0.04194	
0.900	0.08223	0.04626		0.08223	0.04637	
0.920	0.08533	0.03092		0.08533	0.05011	
0.930	0.08843	0.02281		0.08843	0.05204	
0.940	0.09153	0.01643		0.09153	0.05401	-0.05398
0.950	0.09462	0.00577		0.09462	0.05604	-0.05519
0.960	0.09772	0.00316		0.09772	0.05811	-0.05555
0.970	0.10082	0.01234		0.10082	0.06024	-0.05513
0.980	0.10392	0.02173		0.10392	0.06242	-0.05383
0.990	0.10702	0.03131		0.10702	0.06445	-0.05127
1.000	0.11012	0.04110		0.11012	0.06694	-0.04302

EXTERNAL CONTOUR  
TO 1 TO REV. 1 PART NO. TITLE - SAINT LOX TURBINE 3RD BLADE  
SUBTITLE END NO.  
PRETEST NOT USED FOR TD PRINTOUT.

DATE 06/24/87 TIME 13:24:26  
COLD RADIUS = 0.0 THERMAL SHRINK FACTOR = 1.000000

PCT	X	Y	TOP	Y	TOP	(CIRCLE)	X	BOT	Y	BOT	(CIRCLE)
0.0	-0.246688	0.014682	0.04151	0.01628	-0.24688	0.01368	0.01628				
0.010	-0.24200	0.04151			-0.24200	-0.00691					
0.020	-0.23711	0.05530			-0.23711	-0.01373					
0.030	-0.23222	0.06770			-0.23222	-0.01804					
0.040	-0.22734	0.07697			-0.22734	-0.02099					
0.050	-0.22245	0.08932			-0.22245	-0.02303					
0.060	-0.21756	0.09889			-0.21756	-0.02441					
0.070	-0.21268	0.10776			-0.21268	-0.02526					
0.080	-0.20779	0.11605			-0.20779	-0.02567					
0.090	-0.20290	0.12380			-0.20290	-0.02572					
0.100	-0.19801	0.13107			-0.19801	-0.02545					
0.125	-0.18580	0.14739			-0.18580	-0.02354					
0.150	-0.17358	0.16143			-0.17358	-0.02048					
0.175	-0.16136	0.17356			-0.16136	-0.01826					
0.200	-0.14915	0.18397			-0.14915	-0.01635					
0.225	-0.13693	0.19287			-0.13693	-0.01496					
0.250	-0.12471	0.20037			-0.12471	-0.01410					
0.275	-0.111250	0.20657			-0.111250	-0.01377					
0.300	-0.10028	0.21154			-0.10028	-0.01397					
0.325	-0.08806	0.21533			-0.08806	-0.01472					
0.350	-0.07585	0.21799			-0.07585	-0.01603					
0.375	-0.06363	0.21954			-0.06363	-0.01791					
0.400	-0.05141	0.21997			-0.05141	-0.02038					
0.425	-0.03919	0.21931			-0.03919	-0.02345					
0.450	-0.02698	0.21752			-0.02698	-0.02714					
0.475	-0.01476	0.21458			-0.01476	-0.03147					
0.500	-0.00254	0.21047			-0.00254	-0.03647					
0.525	0.00967	0.20513			0.00967	-0.04216					
0.550	0.02189	0.19847			0.02189	-0.04857					
0.575	0.03411	0.19040			0.03411	-0.05573					
0.600	0.04632	0.18070			0.04632	-0.06369					
0.625	0.05854	0.16945			0.05854	-0.07249					
0.650	0.07076	0.15614			0.07076	-0.08217					
0.675	0.08298	0.14050			0.08298	-0.09281					
0.700	0.09519	0.12206			0.09519	-0.10446					
0.725	0.10741	0.10040			0.10741	-0.11722					
0.750	0.11963	0.07526			0.11963	-0.13118					
0.775	0.13184	0.04661			0.13184	-0.14646					
0.800	0.14406	0.01477			0.14406	-0.16319					
0.825	0.15628	-0.01982			0.15628	-0.18158					
0.850	0.16849	-0.05666			0.16849	-0.20184					
0.875	0.18071	-0.09529			0.18071	-0.22427					
0.900	0.19293	-0.13532			0.19293	-0.24928					
0.950	0.21736	-0.21838			0.21736	-0.30961					
0.910	0.19781	-0.15165			0.19781	-0.26014					
0.920	0.20270	-0.16813			0.20270	-0.27154					
0.930	0.20759	-0.18476			0.20759	-0.28353					
0.940	0.21248	-0.20151			0.21248	-0.29620					
0.950	0.21736	-0.21838			0.21736	-0.31579					
0.960	0.22225	-0.23535			0.22225	-0.32388					
0.970	0.22714	-0.25243			0.22714	-0.331819					
0.980	0.23202	-0.26959			0.23202	-0.33549					
0.990	0.23691	-0.28684			0.23691	-0.337320					
1.000	0.24180	-0.30415			0.24180	-0.33925					

NO. 1 CORE CONTOUR  
TD 1 TO REV.  
SUBTITLE 1 PART NO.  
TITLE - SAIP LOK TURBINE 360 BLADE

END NO.  
HOT RADIUS = 4.90700  
COLD RADIUS = 0.0  
THERMAL SHRINK FACTOR = 1.00000  
CYLINDRICAL

PRETMIST NOT USED FOR TD PRINTOUT.

PCT X	X TOP	Y TOP	(CIRCLE)	X BOT	Y BOT	(CIRCLE)
0.0	-0.19692	0.03664	0.0	-0.19692	0.02067	0.03634
0.010	-0.19192	0.04660		-0.19192	0.02135	0.02810
0.020	-0.18665	0.05415		-0.18665	0.02203	0.02552
0.030	-0.18578	0.06126		-0.18578	0.02271	0.02420
0.040	-0.18271	0.06799		-0.18271	0.02338	0.02374
0.050	-0.17944	0.07451		-0.17944	0.02403	
0.060	-0.17658	0.08046		-0.17658	0.02466	
0.070	-0.17251	0.08581		-0.17251	0.02526	
0.080	-0.17044	0.09144		-0.17044	0.02583	
0.090	-0.16737	0.09598		-0.16737	0.02637	
0.100	-0.16430	0.10067		-0.16430	0.02696	
0.125	-0.15663	0.11154		-0.15663	0.02804	
0.150	-0.14995	0.12232		-0.14995	0.02903	
0.175	-0.14126	0.13010		-0.14126	0.02993	
0.200	-0.13361	0.13791		-0.13361	0.03045	
0.225	-0.12553	0.14494		-0.12553	0.03090	
0.250	-0.11826	0.15096		-0.11826	0.03116	
0.275	-0.11059	0.15635		-0.11059	0.03124	
0.300	-0.10221	0.16100		-0.10221	0.03114	
0.325	-0.09524	0.16497		-0.09524	0.03085	
0.350	-0.08757	0.16925		-0.08757	0.03036	
0.375	-0.07990	0.17089		-0.07990	0.02972	
0.400	-0.07222	0.17286		-0.07222	0.02887	
0.425	-0.06455	0.17420		-0.06455	0.02763	
0.450	-0.05688	0.17486		-0.05688	0.02659	
0.475	-0.04920	0.17491		-0.04920	0.02516	
0.500	-0.04153	0.17629		-0.04153	0.02352	
0.525	-0.03386	0.17560		-0.03386	0.02168	
0.550	-0.02618	0.17016		-0.02618	0.01964	
0.575	-0.01851	0.16860		-0.01851	0.01739	
0.600	-0.01084	0.16506		-0.01084	0.01491	
0.625	-0.00316	0.16000		-0.00316	0.01223	
0.650	0.00451	0.15619		0.00451	0.00932	
0.675	0.01218	0.15085		0.01218	0.00617	
0.700	0.01965	0.14415		0.01965	0.00280	
0.725	0.02753	0.11903		0.02753	-0.00080	
0.750	0.03520	0.12649		0.03520	-0.00466	
0.825	0.05382	0.09425		0.05322	-0.01774	
0.850	0.06589	0.08244		0.06589	-0.02264	
0.875	0.07557	0.06750		0.07557	-0.02782	
0.900	0.08124	0.05696		0.08124	-0.03329	
0.910	0.08431	0.04377		0.08431	-0.03557	
0.920	0.08738	0.03646		0.08738	-0.03789	
0.930	0.09045	0.02853		0.09045	-0.04026	
0.940	0.09352	0.02120		0.09352	-0.04268	-0.04242
0.950	0.09658	0.01325		0.09658	-0.04515	-0.04357
0.960	0.09955	0.00509		0.09955	-0.04767	-0.04388
0.970	0.10272	-0.00124		0.10272	-0.04244	
0.980	0.10579	-0.10175		0.10579	-0.05289	-0.0423
0.990	0.10886	-0.02042		0.10886	-0.05557	-0.03957
1.000	0.11193	-0.02225	-0.03135	0.11193	-0.05831	-0.0325

EXTERNAL CONTOUR  
TD 1 TD REV. 1 PART NO. END NO.  
SUBTITLE

TITLE - SAINT LOX TURBINE 3RD BLADE  
DATE 06/24/87 TIME 13:24:26  
COLD RADIUS = 0.0 THERMAL SHRINK FACTOR = 1.00000

PRETRUST NOT USED FOR TD PRINTOUT.

PCT X	X TOP	Y TOP	(CIRCLE)	X BOT	Y BOT	(CIRCLE)
0.0	-0.23171	0.04712	0.04657	-0.23171	0.04689	0.04657
0.010	-0.22692	0.07501		-0.22692	0.02293	
0.020	-0.22214	0.09065		-0.22214	0.01569	
0.030	-0.21735	0.10402		-0.21735	0.01114	
0.040	-0.21257	0.11572		-0.21257	0.00896	
0.050	-0.20778	0.12632		-0.20778	0.00595	
0.060	-0.20299	0.13587		-0.20299	0.00456	
0.070	-0.19821	0.14460		-0.19821	0.00373	
0.080	-0.19342	0.15266		-0.19342	0.00339	
0.090	-0.18864	0.16006		-0.18864	0.00342	
0.100	-0.18385	0.16697		-0.18385	0.00362	
0.125	-0.17189	0.18223		-0.17189	0.00612	
0.150	-0.15992	0.19513		-0.15992	0.01000	
0.175	-0.14796	0.20604		-0.14796	0.01390	
0.200	-0.13599	0.21527		-0.13599	0.01703	
0.225	-0.12403	0.22298		-0.12403	0.01936	
0.250	-0.11207	0.22933		-0.11207	0.02095	
0.275	-0.10010	0.23442		-0.10010	0.02175	
0.300	-0.08814	0.23832		-0.08814	0.02180	
0.325	-0.07617	0.24107		-0.07617	0.02104	
0.350	-0.06421	0.24274		-0.06421	0.01953	
0.375	-0.05224	0.24333		-0.05224	0.01731	
0.400	-0.04028	0.24286		-0.04028	0.01426	
0.425	-0.02831	0.24131		-0.02831	0.01042	
0.450	-0.01635	0.23867		-0.01635	0.00579	
0.475	-0.00439	0.23492		-0.00439	0.00034	
0.500	0.00758	0.23000		0.00758	-0.00593	
0.525	0.01954	0.22386		0.01954	-0.01305	
0.550	0.03151	0.21639		0.03161	-0.02102	
0.575	0.04347	0.20746		0.04347	-0.02988	
0.600	0.05544	0.19693		0.05544	-0.03945	
0.625	0.06740	0.18454		0.06740	-0.05037	
0.650	0.07937	0.16995		0.07937	-0.06007	
0.675	0.09133	0.15268		0.09133	-0.07480	
0.700	0.10329	0.13222		0.10329	-0.08858	
0.725	0.11526	0.10825		0.11526	-0.10550	
0.750	0.12722	0.08079		0.12722	-0.11960	
0.775	0.13919	0.05014		0.13919	-0.13695	
0.800	0.15115	0.01680		0.15115	-0.15566	
0.825	0.16312	-0.01867		0.16312	-0.17580	
0.850	0.17508	-0.05577		0.17508	-0.19751	
0.875	0.18704	-0.09415		0.18704	-0.22093	
0.900	0.19901	-0.13347		0.19901	-0.24625	
0.910	0.20380	-0.14941		0.20380	-0.25695	
0.920	0.20858	-0.16546		0.20858	-0.26800	
0.930	0.21337	-0.18160		0.21337	-0.27943	
0.940	0.21815	-0.19783		0.21815	-0.29124	
0.950	0.22294	-0.21413		0.22294	-0.30348	-0.30344
0.960	0.22772	-0.23051		0.22772	-0.3115	-0.30896
0.970	0.23251	-0.24696		0.23251	-0.32930	-0.31073
0.980	0.23730	-0.26346		0.23730	-0.34223	-0.31052
0.990	0.24208	-0.28000		0.24208	-0.35710	-0.30821
1.000	0.24687	-0.29661	-0.29837	0.24687	-0.37186	-0.29837

NO. 1 CORE CONTOUR  
TD 1 TD REV.  
SUBTITLE 1 PART NO.  
TITLE - SATP LOX TURBINE 3RD BLADE

END NO. 5.11500  
COLD RADIUS = 0.0  
THERMAL SHRINK FACTOR = 1.00000

PRETHISIT NOT USED FOR TD PRINTOUT.

PCT	X	X TOP	Y TOP	(CIRCLE)	X BOT	Y BOT	(CIRCLE)
0.0	-0.18715	0.06244	0.06072	-0.18715	0.04229	0.04229	0.06072
0.010	-0.18409	0.07351	0.07351	-0.16409	0.04412	0.04412	0.05255
0.020	-0.18102	0.08369	0.08369	-0.16102	0.04522	0.04522	0.04997
0.030	-0.17796	0.09299	0.09299	-0.17796	0.04630	0.04630	0.04864
0.040	-0.17490	0.10140	0.10140	-0.17490	0.04736	0.04736	0.04817
0.050	-0.17184	0.10895	0.10895	-0.17184	0.04838	0.04838	0.04845
0.060	-0.16877	0.11566	0.11566	-0.16877	0.04938	0.04938	0.04947
0.070	-0.16571	0.12162	0.12162	-0.16571	0.05034	0.05034	0.05047
0.080	-0.16265	0.12697	0.12697	-0.16265	0.05127	0.05127	0.05136
0.090	-0.15958	0.13183	0.13183	-0.15958	0.05216	0.05216	0.05223
0.100	-0.15652	0.13635	0.13635	-0.15652	0.05303	0.05303	0.05311
0.125	-0.14886	0.14684	0.14684	-0.14886	0.05503	0.05503	0.05517
0.150	-0.14121	0.15644	0.15644	-0.14121	0.05681	0.05681	0.05701
0.175	-0.13355	0.16495	0.16495	-0.13355	0.05833	0.05833	0.05852
0.200	-0.12589	0.17229	0.17229	-0.12589	0.05956	0.05956	0.06002
0.225	-0.11823	0.17965	0.17965	-0.11823	0.06053	0.06053	0.06100
0.250	-0.11058	0.18419	0.18419	-0.11058	0.06123	0.06123	0.06170
0.275	-0.10292	0.18898	0.18898	-0.10292	0.06167	0.06167	0.06229
0.300	-0.09526	0.19303	0.19303	-0.09526	0.06186	0.06186	0.06249
0.325	-0.08761	0.19638	0.19638	-0.08761	0.06186	0.06186	0.06249
0.350	-0.07995	0.19933	0.19933	-0.07995	0.06186	0.06186	0.06249
0.375	-0.07229	0.20166	0.20166	-0.07229	0.06229	0.06229	0.06271
0.400	-0.06463	0.20243	0.20243	-0.06463	0.06304	0.06304	0.06379
0.425	-0.05698	0.20319	0.20319	-0.05698	0.06383	0.06383	0.06442
0.450	-0.04932	0.20330	0.20330	-0.04932	0.06467	0.06467	0.06521
0.475	-0.04166	0.20281	0.20281	-0.04166	0.06552	0.06552	0.06616
0.500	-0.03401	0.20169	0.20169	-0.03401	0.06639	0.06639	0.06701
0.525	-0.02635	0.19994	0.19994	-0.02635	0.06716	0.06716	0.06775
0.550	-0.01869	0.19756	0.19756	-0.01869	0.06804	0.06804	0.06871
0.575	-0.01103	0.19452	0.19452	-0.01103	0.06891	0.06891	0.06950
0.600	-0.00338	0.19081	0.19081	-0.00338	0.06979	0.06979	0.07038
0.625	0.00426	0.18640	0.18640	0.00426	0.07066	0.07066	0.07135
0.650	0.01194	0.18125	0.18125	0.01194	0.07153	0.07153	0.07224
0.675	0.01959	0.17530	0.17530	0.01959	0.07241	0.07241	0.07311
0.700	0.02725	0.16853	0.16853	0.02725	0.07328	0.07328	0.07400
0.725	0.03491	0.16061	0.16061	0.03491	0.07415	0.07415	0.07486
0.750	0.04257	0.15205	0.15205	0.04257	0.07502	0.07502	0.07573
0.775	0.05022	0.14207	0.14207	0.05022	0.07589	0.07589	0.07650
0.800	0.05788	0.13073	0.13073	0.05788	0.07676	0.07676	0.07727
0.825	0.06554	0.11786	0.11786	0.06554	0.07763	0.07763	0.07814
0.850	0.07319	0.10340	0.10340	0.07319	0.07850	0.07850	0.07937
0.875	0.08085	0.08732	0.08732	0.08085	0.07937	0.07937	0.08024
0.900	0.08851	0.06972	0.06972	0.08851	0.08022	0.08022	0.08111
0.910	0.09157	0.06228	0.06228	0.09157	0.08108	0.08108	0.08195
0.920	0.09463	0.05461	0.05461	0.09463	0.08195	0.08195	0.08282
0.930	0.09770	0.04675	0.04675	0.09770	0.08298	0.08298	0.08381
0.940	0.10076	0.03869	0.03869	0.10076	0.08395	0.08395	0.08477
0.950	0.10392	0.03045	0.03045	0.10392	0.08493	0.08493	0.08573
0.960	0.10689	0.02202	0.02202	0.10689	0.08591	0.08591	0.08675
0.970	0.10995	0.01342	0.01342	0.10995	0.08689	0.08689	0.08771
0.980	0.11301	0.00468	0.00468	0.11301	0.08786	0.08786	0.08861
0.990	0.11607	-0.00420	-0.00420	0.11607	0.08860	0.08860	0.08946
1.000	0.11914	-0.01322	-0.01322	0.11914	0.08951	0.08951	0.09027

EXTERNAL CURVATURE  
TD 1 TD REV. 1 PART NO. TITLE - SATP LOX TURBINE 3RD BLADE  
SUBTITLE END NO. 5.32200 COLD RADIUS = 0.0 THERMAL SHRINK FACTOR = 1.000000

PRETMIST NOT USED FOR TD PRINTOUT.

PCT	X	Y	TOP	Y	TOP	(CIRCLE)	X	BOT	Y	BOT	(CIRCLE)
0.0	-0.21660	0.08368	0.08366	-0.21660	0.08352	0.08352	0.0	0.08352	0.08352	0.08352	0.08352
0.010	-0.21191	0.11160	0.11160	-0.21191	0.06094	0.06094	0.0	0.06094	0.06094	0.06094	0.06094
0.020	-0.20723	0.12548	0.12548	-0.20723	0.05382	0.05382	0.0	0.05382	0.05382	0.05382	0.05382
0.030	-0.20254	0.13765	0.13765	-0.20254	0.04935	0.04935	0.0	0.04935	0.04935	0.04935	0.04935
0.040	-0.19786	0.14844	0.14844	-0.19786	0.04628	0.04628	0.0	0.04628	0.04628	0.04628	0.04628
0.050	-0.19217	0.15816	0.15816	-0.19217	0.04415	0.04415	0.0	0.04415	0.04415	0.04415	0.04415
0.060	-0.18649	0.16700	0.16700	-0.18649	0.04271	0.04271	0.0	0.04271	0.04271	0.04271	0.04271
0.070	-0.18181	0.17512	0.17512	-0.18181	0.04183	0.04183	0.0	0.04183	0.04183	0.04183	0.04183
0.080	-0.17912	0.18262	0.18262	-0.17912	0.04140	0.04140	0.0	0.04140	0.04140	0.04140	0.04140
0.090	-0.17444	0.18958	0.18958	-0.17444	0.04135	0.04135	0.0	0.04135	0.04135	0.04135	0.04135
0.100	-0.16975	0.19605	0.19605	-0.16975	0.04163	0.04163	0.0	0.04163	0.04163	0.04163	0.04163
0.125	-0.15804	0.21044	0.21044	-0.15804	0.04362	0.04362	0.0	0.04362	0.04362	0.04362	0.04362
0.150	-0.14633	0.22266	0.22266	-0.14633	0.04713	0.04713	0.0	0.04713	0.04713	0.04713	0.04713
0.175	-0.14462	0.23506	0.23506	-0.14462	0.05116	0.05116	0.0	0.05116	0.05116	0.05116	0.05116
0.200	-0.12291	0.24189	0.24189	-0.12291	0.05664	0.05664	0.0	0.05664	0.05664	0.05664	0.05664
0.225	-0.11120	0.24932	0.24932	-0.11120	0.05906	0.05906	0.0	0.05906	0.05906	0.05906	0.05906
0.250	-0.09948	0.25548	0.25548	-0.09948	0.06348	0.06348	0.0	0.06348	0.06348	0.06348	0.06348
0.275	-0.08777	0.26046	0.26046	-0.08777	0.05959	0.05959	0.0	0.05959	0.05959	0.05959	0.05959
0.300	-0.07606	0.26431	0.26431	-0.07606	0.05823	0.05823	0.0	0.05823	0.05823	0.05823	0.05823
0.325	-0.06435	0.26710	0.26710	-0.06435	0.05700	0.05700	0.0	0.05700	0.05700	0.05700	0.05700
0.350	-0.05264	0.26882	0.26882	-0.05264	0.05686	0.05686	0.0	0.05686	0.05686	0.05686	0.05686
0.375	-0.04093	0.26953	0.26953	-0.04093	0.05186	0.05186	0.0	0.05186	0.05186	0.05186	0.05186
0.400	-0.02922	0.26920	0.26920	-0.02922	0.04796	0.04796	0.0	0.04796	0.04796	0.04796	0.04796
0.425	-0.01750	0.26785	0.26785	-0.01750	0.04315	0.04315	0.0	0.04315	0.04315	0.04315	0.04315
0.450	-0.00579	0.26542	0.26542	-0.00579	0.03743	0.03743	0.0	0.03743	0.03743	0.03743	0.03743
0.475	0.00592	0.26190	0.26190	0.00592	0.03080	0.03080	0.0	0.03080	0.03080	0.03080	0.03080
0.500	0.01763	0.25720	0.25720	0.01763	0.02324	0.02324	0.0	0.02324	0.02324	0.02324	0.02324
0.525	0.02934	0.25127	0.25127	0.02934	0.01672	0.01672	0.0	0.01672	0.01672	0.01672	0.01672
0.550	0.04105	0.24398	0.24398	0.04105	0.00527	0.00527	0.0	0.00527	0.00527	0.00527	0.00527
0.575	0.05276	0.23519	0.23519	0.05276	0.00517	0.00517	0.0	0.00517	0.00517	0.00517	0.00517
0.600	0.06448	0.22467	0.22467	0.06448	0.01660	0.01660	0.0	0.01660	0.01660	0.01660	0.01660
0.625	0.07619	0.21213	0.21213	0.07619	0.02902	0.02902	0.0	0.02902	0.02902	0.02902	0.02902
0.650	0.08790	0.19707	0.19707	0.08790	0.04250	0.04250	0.0	0.04250	0.04250	0.04250	0.04250
0.675	0.09961	0.17884	0.17884	0.09961	0.05702	0.05702	0.0	0.05702	0.05702	0.05702	0.05702
0.700	0.11132	0.15695	0.15695	0.11132	0.07263	0.07263	0.0	0.07263	0.07263	0.07263	0.07263
0.725	0.12203	0.13684	0.13684	0.12203	0.08935	0.08935	0.0	0.08935	0.08935	0.08935	0.08935
0.750	0.13474	0.10109	0.10109	0.13474	0.10722	0.10722	0.0	0.10722	0.10722	0.10722	0.10722
0.775	0.14646	0.06813	0.06813	0.14646	0.12629	0.12629	0.0	0.12629	0.12629	0.12629	0.12629
0.800	0.15817	0.03770	0.03770	0.15817	0.14659	0.14659	0.0	0.14659	0.14659	0.14659	0.14659
0.825	0.16988	-0.04958	-0.04958	0.16988	0.16816	0.16816	0.0	0.16816	0.16816	0.16816	0.16816
0.850	0.18159	-0.04322	-0.04322	0.18159	0.19106	0.19106	0.0	0.19106	0.19106	0.19106	0.19106
0.875	0.19330	-0.04287	-0.04287	0.19330	0.21535	0.21535	0.0	0.21535	0.21535	0.21535	0.21535
0.900	0.20501	-0.12325	-0.12325	0.20501	0.26111	0.26111	0.0	0.26111	0.26111	0.26111	0.26111
0.910	0.20970	-0.13957	-0.13957	0.20970	0.25183	0.25183	0.0	0.25183	0.25183	0.25183	0.25183
0.920	0.21436	-0.15577	-0.15577	0.21436	0.26281	0.26281	0.0	0.26281	0.26281	0.26281	0.26281
0.930	0.21907	-0.17244	-0.17244	0.21907	0.27404	0.27404	0.0	0.27404	0.27404	0.27404	0.27404
0.940	0.22375	-0.18897	-0.18897	0.22375	0.28553	0.28553	0.0	0.28553	0.28553	0.28553	0.28553
0.950	0.22683	-0.20556	-0.20556	0.22683	0.29729	0.29729	0.0	0.29729	0.29729	0.29729	0.29729
0.960	0.23312	-0.22220	-0.22220	0.23312	0.30175	0.30175	0.0	0.30175	0.30175	0.30175	0.30175
0.970	0.23780	-0.23888	-0.23888	0.23780	0.32164	0.32164	0.0	0.32164	0.32164	0.32164	0.32164
0.980	0.24249	-0.25562	-0.25562	0.24249	0.34425	0.34425	0.0	0.34425	0.34425	0.34425	0.34425
0.990	0.24717	-0.27240	-0.27240	0.24717	0.36715	0.36715	0.0	0.36715	0.36715	0.36715	0.36715
1.000	0.25186	-0.28921	-0.28921	0.25186	0.36035	0.36035	0.0	0.36035	0.36035	0.36035	0.36035

NO. 1 CORE CONTOUR  
TD 1 TD REV. 1 PART NO. TITLE - SATP LOX TURBINE 3RD BLADE  
SUBTITLE END NO.

HOT RADIUS = 5.32200

DATE 06/24/87 TIME 13:24:26  
COLD RADIUS = 0.0 THERMAL SHRINK FACTOR = 1.00000

PRETWIST NOT USED FOR TD PRINTOUT.

PCT X	X TOP	Y TOP	(CIRCLE)	X BOT	Y BOT	(CIRCLE)
0.0	-0.17396	0.02331	0.02194	-0.17336	0.02651	0.02124
0.010	-0.17088	0.01643		-0.17088	0.02694	0.02374
0.020	-0.16780	0.01825		-0.16780	0.02749	0.02119
0.030	-0.16473	0.02876		-0.16473	0.02816	0.02990
0.040	-0.16165	0.03803		-0.16165	0.02823	0.02448
0.050	-0.15857	0.04607		-0.15857	0.02981	0.02983
0.060	-0.15549	0.05298		-0.15549	0.02077	
0.070	-0.15242	0.05893		-0.15242	0.02179	
0.080	-0.14934	0.16415		-0.14934	0.02285	
0.090	-0.14626	0.16882		-0.14626	0.02392	
0.100	-0.14318	0.17312		-0.14318	0.02497	
0.125	-0.13549	0.18298		-0.13549	0.02737	
0.150	-0.12779	0.19166		-0.12779	0.02928	
0.175	-0.12010	0.19930		-0.12010	0.02975	
0.200	-0.11240	0.20601		-0.11240	0.02987	
0.225	-0.10471	0.21191		-0.10471	0.02987	
0.250	-0.09701	0.21703		-0.09701	0.03127	
0.275	-0.08932	0.22144		-0.08932	0.03156	
0.300	-0.08162	0.22517		-0.08162	0.03152	
0.325	-0.07393	0.22826		-0.07393	0.03118	
0.350	-0.06624	0.23072		-0.06624	0.02952	
0.375	-0.05854	0.23257		-0.05854	0.02953	
0.400	-0.05085	0.23381		-0.05085	0.02923	
0.425	-0.04315	0.23445		-0.04315	0.02861	
0.450	-0.03546	0.23449		-0.03546	0.02869	
0.475	-0.02776	0.23393		-0.02776	0.02844	
0.500	-0.02007	0.23276		-0.02007	0.02887	
0.525	-0.01237	0.23094		-0.01237	0.02897	
0.550	-0.00468	0.22851		-0.00468	0.02757	
0.575	0.00302	0.22539		0.00302	0.02719	
0.600	0.01071	0.22157		0.01071	0.02631	
0.625	0.01841	0.21701		0.01841	0.02406	
0.650	0.02610	0.21164		0.02610	0.02449	
0.675	0.03380	0.20539		0.03380	0.02454	
0.700	0.04149	0.19817		0.04149	0.02426	
0.725	0.04918	0.18986		0.04918	0.02360	
0.750	0.05688	0.18024		0.05688	0.02359	
0.775	0.06457	0.16904		0.06457	0.02120	
0.800	0.07227	0.15611		0.07227	0.02444	
0.825	0.07996	0.14130		0.07996	0.01728	
0.850	0.08766	0.12454		0.08766	0.00974	
0.875	0.09535	0.10602		0.09535	0.00160	
0.900	0.10305	0.08591		0.10305	-0.00654	
0.910	0.10613	0.07744		0.10613	-0.01000	
0.920	0.10920	0.06876		0.10920	-0.01553	
0.930	0.11228	0.05989		0.11228	-0.01712	-0.01708
0.940	0.11536	0.05085		0.11536	-0.02077	-0.01941
0.950	0.11844	0.04165		0.11844	-0.02450	-0.02058
0.960	0.12151	0.03229		0.12151	-0.02829	-0.02091
0.970	0.12459	0.02276		0.12459	-0.03216	-0.02047
0.980	0.12767	0.01313		0.12767	-0.03609	-0.01917
0.990	0.13075	0.00338		0.13075	-0.04010	-0.01661
1.000	0.13383	-0.00643		0.13383	-0.04417	-0.00838

EXTERNAL CONTOUR  
TD 1 TD REV. 1 PART NO. TITLE - SATP LOX TURBINE 3RD BLADE  
END NO. HOT RADIUS = 5.53000 DATE 06/24/87 TIME 13:24:26  
SUBTITLE COLD RADIUS = 0.0 THERMAL SHRINK FACTOR = 1.00000

PRETHIST NOT USED FOR TD PRINTOUT.

PCT X	X TOP	Y TOP	(CIRCLE)	X BOT	Y BOT	(CIRCLE)
0.0	-0.20337	0.12224	0.12867	-0.20137	0.12803	0.12867
0.010	-0.19679	0.15364		-0.19679	0.10888	
0.020	-0.19220	0.16524		-0.19220	0.10236	
0.030	-0.16762	0.17674		-0.16762	0.09616	
0.040	-0.18304	0.18365		-0.18304	0.09520	
0.050	-0.17845	0.19205		-0.17845	0.09308	
0.060	-0.17587	0.19996		-0.17587	0.09156	
0.070	-0.16929	0.20443		-0.16929	0.09051	
0.080	-0.16471	0.21450		-0.16471	0.08986	
0.090	-0.16012	0.22118		-0.16012	0.08954	
0.100	-0.15554	0.22449		-0.15554	0.08951	
0.115	-0.14408	0.24184		-0.14408	0.08952	
0.150	-0.13262	0.25629		-0.13262	0.09280	
0.175	-0.12117	0.26505		-0.12117	0.09548	
0.200	-0.10971	0.27424		-0.10971	0.09727	
0.225	-0.09825	0.28197		-0.09825	0.09814	
0.250	-0.08679	0.28833		-0.08679	0.09810	
0.275	-0.07534	0.29337		-0.07534	0.09714	
0.300	-0.06388	0.29714		-0.06388	0.09527	
0.325	-0.05242	0.29966		-0.05242	0.09248	
0.350	-0.04096	0.30095		-0.04096	0.08877	
0.375	-0.02951	0.30102		-0.02951	0.08412	
0.400	-0.01805	0.29985		-0.01805	0.07856	
0.425	-0.00659	0.29443		-0.00659	0.07207	
0.450	0.00487	0.29373		0.00487	0.06464	
0.475	0.01632	0.28669		0.01632	0.05620	
0.500	0.02778	0.26824		0.02778	0.04697	
0.525	0.03924	0.27431		0.03924	0.03671	
0.550	0.05069	0.26476		0.05069	0.02550	
0.575	0.06215	0.25346		0.06215	0.01333	
0.600	0.07361	0.24022		0.07361	0.00118	
0.625	0.08507	0.22472		0.08507	-0.01394	
0.650	0.09652	0.20663		0.09652	-0.02904	
0.675	0.10798	0.18568		0.10798	-0.04515	
0.700	0.11944	0.16170		0.11944	-0.06224	
0.725	0.13090	0.13470		0.13090	-0.08035	
0.750	0.14235	0.10488		0.14235	-0.09949	
0.775	0.15381	0.07253		0.15381	-0.11966	
0.800	0.16527	0.03800		0.16527	-0.14089	
0.825	0.17673	0.00166		0.17673	-0.16317	
0.850	0.18818	-0.03616		0.18818	-0.18652	
0.875	0.19964	-0.07518		0.19964	-0.21097	
0.900	0.21110	-0.11519		0.21110	-0.23651	
0.910	0.21568	-0.13142		0.21568	-0.24705	
0.920	0.22027	-0.14777		0.22027	-0.25776	
0.930	0.22585	-0.16422		0.22585	-0.26866	
0.940	0.22943	-0.18077		0.22943	-0.27974	
0.950	0.23401	-0.19741		0.23401	-0.29100	-0.29033
0.960	0.23860	-0.21413		0.23860	-0.30245	-0.29467
0.970	0.24318	-0.23094		0.24318	-0.31408	-0.29585
0.980	0.24776	-0.24782		0.24776	-0.32591	-0.29546
0.990	0.25235	-0.26476		0.25235	-0.33792	-0.29309
1.000	0.25693	-0.28176	-0.28341	0.25693	-0.35012	-0.28341

NO. 1 CORE JANTOUR  
TD 1 TD REV. 1 PART NO. END NO.  
SUBTITLE HOT RADIUS = 5.53000

TITLE - SATP LOX TURBINE 390 BLADE  
DATE 06/24/87 TIME 13:24:16  
COLD RADIUS = 0.0 THERMAL SHRINK FACTOR = 1.00000

PRETWIST NOT USED FOR TD PRINTOUT.

PCT X	X TOP	Y TOP	(CIRCLE)	X BOT	Y BOT	(CIRCLE)
0.0	-0.15895	0.13537	0.13369	-0.15895	0.11760	0.13362
0.010	-0.15587	0.14622		-0.15587	0.11836	0.12544
0.020	-0.15279	0.15610		-0.15279	0.11913	0.12286
0.030	-0.14972	0.16526		-0.14972	0.11989	0.12154
0.040	-0.14664	0.17350		-0.14664	0.12065	0.12102
0.050	-0.14356	0.18093		-0.14356	0.12139	0.12139
0.060	-0.14049	0.18679		-0.14049	0.12210	
0.070	-0.13741	0.19379		-0.13741	0.12278	
0.080	-0.13433	0.19952		-0.13433	0.12342	
0.090	-0.13125	0.20494		-0.13125	0.12404	
0.100	-0.12818	0.21013		-0.12818	0.12463	
0.125	-0.12048	0.22206		-0.12048	0.12595	
0.150	-0.11279	0.23194		-0.11279	0.12703	
0.175	-0.10510	0.23958		-0.10510	0.12780	
0.200	-0.09741	0.24585		-0.09741	0.12820	
0.225	-0.08971	0.25156		-0.08971	0.12822	
0.250	-0.08202	0.25670		-0.08202	0.12790	
0.275	-0.07433	0.26105		-0.07433	0.12722	
0.300	-0.06664	0.26456		-0.06664	0.12622	
0.325	-0.05894	0.26732		-0.05894	0.12487	
0.350	-0.05125	0.26335		-0.05125	0.12318	
0.375	-0.04356	0.27042		-0.04356	0.12115	
0.400	-0.03587	0.27114		-0.03587	0.11976	
0.425	-0.02817	0.27087		-0.02817	0.11601	
0.450	-0.02048	0.26935		-0.02048	0.11291	
0.475	-0.01279	0.26802		-0.01279	0.10946	
0.500	-0.00510	0.26541		-0.00510	0.10565	
0.525	0.00260	0.26201		0.00260	0.10146	
0.550	0.01029	0.25776		0.01029	0.09692	
0.575	0.01796	0.25271		0.01796	0.09199	
0.600	0.02567	0.24678		0.02567	0.08669	
0.625	0.03337	0.23992		0.03337	0.08102	
0.650	0.04106	0.23211		0.04106	0.07696	
0.675	0.04875	0.22324		0.04875	0.06850	
0.700	0.05644	0.21325		0.05644	0.06167	
0.725	0.06414	0.20200		0.06414	0.05442	
0.750	0.07183	0.18943		0.07183	0.04679	
0.775	0.07952	0.17540		0.07952	0.03875	
0.800	0.08721	0.15993		0.08721	0.03031	
0.825	0.09491	0.14299		0.09491	0.02145	
0.850	0.10260	0.12465		0.10260	0.01219	
0.875	0.11029	0.10498		0.11029	0.00249	
0.900	0.11796	0.08610		0.11796	-0.00761	
0.910	0.12104	0.07542		0.12104	-0.01177	
0.920	0.12414	0.06456		0.12414	-0.01601	
0.930	0.12721	0.05755		0.12721	-0.02031	-0.02006
0.940	0.13029	0.04639		0.13029	-0.02467	-0.02238
0.950	0.13337	0.03908		0.13337	-0.02911	-0.02354
0.960	0.13645	0.02961		0.13645	-0.03362	-0.02387
0.970	0.13952	0.02002		0.13952	-0.03821	-0.02343
0.980	0.14260	0.01031		0.14260	-0.04286	-0.02212
0.990	0.14568	0.00049		0.14568	-0.04758	-0.01956
1.000	0.14875	-0.00944	-0.01133	0.14875	-0.05236	-0.01133

## P824 STACKING (OPTION 4)

30° Blade

## CURRENT STACKING

CG ROOT SECTION	X	Y	Z
RAD REF (TYPE 1)	RBX	RRX	RRZ
STACKING OPTION	KOPX	KOPY	KOZZ
TILT	-	1	-
XTIILT	-	0.0600	YTILT
DEGREES	-	-0.2372	RADIANS
RESTAGGER	-	-0.004140	

TABLE 1

TABLE 2

SFC	RADIUS	XOFF0	YOFF0	ZOFF	XOFF	YOFF	ZOFF	SECTION
1	4.7000	-0.2619	-0.3124	-0.2619	-0.3124	-0.3124	0.0	ROT. (DEG)
2	4.9070	-0.2619	-0.3124	-0.2469	-0.3049	-0.3049	0.0	
3	5.1150	-0.2619	-0.3124	-0.2319	-0.2974	-0.2974	0.0	
4	5.3220	-0.2619	-0.3124	-0.2169	-0.2699	-0.2699	0.0	
5	5.5300	-0.2619	-0.3124	-0.2019	-0.2824	-0.2824	0.0	

A.T.P. 10x TURBINE 320 STAGE BLADE  
Endurance 15. Radius

$$\text{Step 1 Area} = 0.0413 \text{ in}^2 \text{ (area for actual flow area)}$$

$$\text{Actual Area} = 0.0413 \text{ in}^2 \text{ (area from next stage area)}$$

$$\text{Stage Area} = 0.0371 \text{ in}^2 \cdot 2 \text{ (first area)}$$

$$= (0.0413 - 0.0371)$$

5.53 TIP  
RADIUS

$$\text{Physical Area Area} = 0.1631 \text{ in}^2 \text{ (tip fillet radius)}$$

$$= 0.1461 \text{ in}^2 \text{ (tip fillet radius)}$$

DRAWING DISTANCE - INCHES

0.11	4.7	4.8	4.9	5.0	5.1	5.2	5.3	5.4	5.5	5.6
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For Radius - inches

6/26/87

B.B. DF117462

## P824 UTILITY PROGRAM - FLOW AREA CALCULATION

SATP LOX TURBINE 3RD BLADE  
 HOT TO COLD CONVERSION NOT AVAILABLE  
 RESTAGGER ANGLE DEGREES = -0.23720 RADIANS = -0.00414  
 PLATFORM RADIUS LE 10 = 0.0 LE OD = 0.0  
 TE 10 = 0.0 TE OD = 0.0  
 GAGING RADIUS INNER = 4.70000 OUTER = 5.53000  
 NUMBER OF BLADES FOR GAGING = 54  
 STAGGER IN DEGREES IS -3.00 TO 3.00 IN INCREMENTS OF 0.50  
 IN CLASS IS - 6 TO 6  
 TOLER = 0.0

STAGGER (DEGREES)	HOT FLOW (SQ IN)	COLD FLOW (CHARGE FLOW AREA (SQ IN))
-3.00000	7.09218	-13.51229
-2.50000	7.27717	-11.25631
-2.00000	7.46211	-9.00108
-1.50000	7.64689	-6.74765
-1.00000	7.83150	-4.49642
-0.50000	8.01594	-2.24719
0.0	8.20021	0.0
0.50000	8.38431	2.24506
1.00000	8.56820	4.48747
1.50000	8.75184	6.72700
2.00000	8.93527	8.96386
2.50000	9.11848	11.19810
3.00000	9.30143	13.42915

0.0 8.152

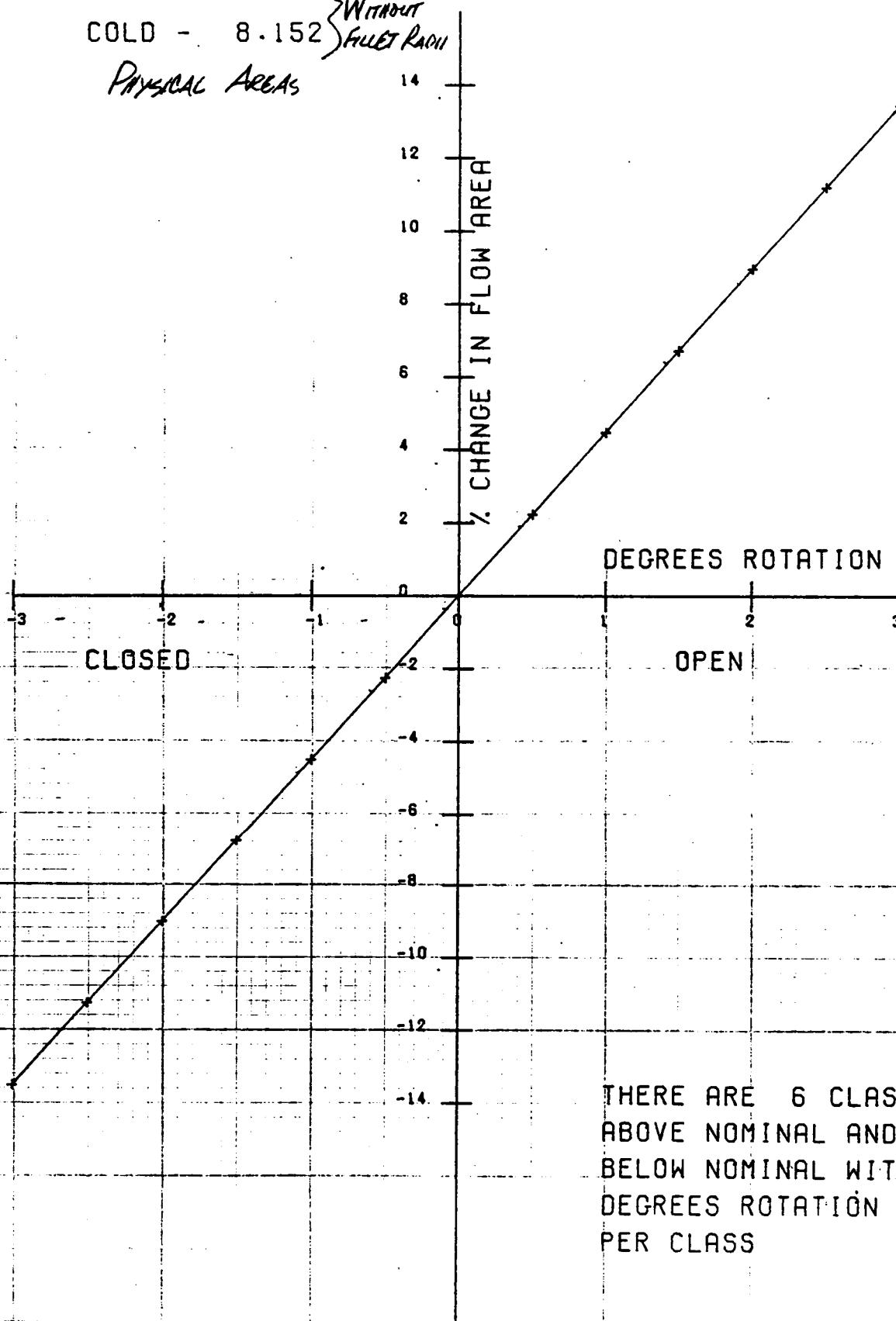
SATP LOX TURBINE 3RD BLADE

NOMINAL FLOW AREA - SQ. IN.

HOT - 8.200  
COLD - 8.152

*Without  
Fillet Radii*

*Physical Areas*



THERE ARE 6 CLASSES  
ABOVE NOMINAL AND 6  
BELOW NOMINAL WITH .050  
DEGREES ROTATION  
PER CLASS

DF117463

31

P024 UTILITY PROGRAM - STRESS CALCULATION

SATP LOX TURBINE 3RD BLADE	
ENGINE OPERATING CONDITION	
WAE	RPM
1	64.6 25000.
XGBR = 29.50000	XGBT = 0.0
YGBR = 26.00000	YGBT = 0.0
DENSITY = 0.31200	WEIGHTING RADIU INNER = 4.7000 OUTER = 5.5300
SHROUD VOLUME = 0.0	SHROUD THICKNESS = 0.0
SHROUD MISALIGNMENT = 0.0	RADIUS OF SHROUD = 0.0

SATP LOX TURBINE 3RD BLADE  
OPERATING CONDITION 1

MAE = 64.6 MPR = 29.5 NCF = 7.4 MFT = 0.0

BPM = 25000. MVR = 26.0 MWF = 6.6 MFT = 0.0

Z/S	RADIUS	SIG P/A	SHRD P/A	LE	TE	CONV.
0	4.7000	19986.	0.	-452.	203.	313.
10	4.7830	18435.	0.	-1553.	-707.	1407.
20	4.8660	16785.	0.	-2190.	-1115.	1971.
30	4.9490	15033.	0.	-2362.	-1129.	2084.
40	5.0320	13182.	0.	-2165.	-907.	1660.
50	5.1150	11233.	0.	-1661.	-607.	1424.
60	5.1980	9189.	0.	-1040.	-345.	904.
70	5.2810	7051.	0.	-529.	-155.	449.
80	5.3640	4816.	0.	-179.	-43.	149.
90	5.4470	2471.	0.	-18.	0.	15.
100	5.5300	0.	0.	0.	0.	0.

Z/S	RADIUS	XOFF	YOFF	LE	TE	CONV.
0	4.7000	0.0	0.0	14318.	9935.	-14011.
10	4.7830	0.0029	0.0033	12635.	8513.	-12004.
20	4.8660	0.0064	0.0079	10747.	7056.	-9946.
30	4.9490	0.0104	0.0115	8756.	5650.	-7900.
40	5.0320	0.0152	0.0200	6783.	4333.	-6116.
50	5.1150	0.0208	0.0267	4946.	3131.	-4434.
60	5.1980	0.0272	0.0332	3327.	2076.	-2966.
70	5.2810	0.0340	0.0395	1985.	1216.	-1758.
80	5.3640	0.0407	0.0455	949.	645.	-835.
90	5.4470	0.0469	0.0511	267.	152.	-232.
100	5.5300	0.0527	0.0562	0.	0.	0.

Z/S	RADIUS	AREA	PULL	LE	TE	CONV.
0	4.7000	0.0624	133.8	0.	0.	0.
10	4.7830	0.0604	131.6	0.	0.	0.
20	4.8660	0.0585	129.9	0.	0.	0.
30	4.9490	0.0567	126.0	0.	0.	0.
40	5.0320	0.0550	126.1	0.	0.	0.
50	5.1150	0.0533	124.2	0.	0.	0.
60	5.1980	0.0516	122.2	0.	0.	0.
70	5.2810	0.0499	119.9	0.	0.	0.
80	5.3640	0.0482	117.4	0.	0.	0.
90	5.4470	0.0464	114.6	0.	0.	0.
100	5.5300	0.0446	0.0	0.	0.	0.

Z/S	RADIUS	HGT	MFT	HGS	MFC	THETA N
0	4.7000	-29.0	-27.8	29.5	26.0	-14.62
10	4.7830	-25.9	-24.3	23.9	21.1	31.99
20	4.8660	-21.9	-20.7	18.9	16.7	36.55
30	4.9490	-17.3	-17.0	14.5	12.6	34.03
40	5.0320	-12.7	-13.3	10.6	9.5	26.72
50	5.1150	-8.7	-9.6	7.4	6.6	22.92
60	5.1980	-5.4	-6.2	4.7	4.3	16.51
70	5.2810	-2.9	-3.4	2.7	2.4	16.64
80	5.3640	-1.2	-1.4	1.2	1.1	6.65
90	5.4470	-0.3	-0.3	0.3	0.3	-14.57
100	5.5300	0.0	0.0	0.0	0.0	0.0

SATP LOX TURBINE 3RD BLADE  
 DENSITY = 0.31200 WEIGHTING RADIU INNER = 4.7000 OUTER = 5.5300  
 SHROUD VOLUME = 0.0 SHROUD THICKNESS = 0.0  
 SHROUD MISALIGNMENT = 0.0 RADIUS OF SHROUD = 0.0  
 HEIGHT OF AIRFOIL = 0.01381 HEIGHT OF SHROUD = 0.0  
 TOTAL WEIGHT = 0.74599 NUMBER OF BLADES = 54

**SUMMARY OF SECTION PROPERTIES**

ZS	RADIUS	AREA	I MIN	I MAX	THETA	X BAR	Y BAR
0	4.7000	0.0624	0.4762E-03	0.1606E-02	-36.61	-0.0000	0.0000
10	4.7830	0.0604	0.4334E-03	0.1594E-02	-38.04	0.0029	0.0033
20	4.8660	0.0585	0.3986E-03	0.1584E-02	-39.45	0.0063	0.0079
30	4.9490	0.0567	0.3704E-03	0.1577E-02	-40.82	0.0104	0.0136
40	5.0320	0.0550	0.3472E-03	0.1571E-02	-42.17	0.0151	0.0200
50	5.1150	0.0533	0.3280E-03	0.1566E-02	-43.52	0.0207	0.0267
60	5.1980	0.0516	0.3115E-03	0.1562E-02	-44.90	0.0272	0.0333
70	5.2810	0.0499	0.2938E-03	0.1559E-02	-46.35	0.0340	0.0396
80	5.3640	0.0482	0.2733E-03	0.1560E-02	-47.84	0.0406	0.0455
90	5.4470	0.0464	0.2486E-03	0.1564E-02	-49.33	0.0468	0.0511
100	5.5300	0.0446	0.2209E-03	0.1572E-02	-50.76	0.0527	0.0562
ZS	RADIUS	K	L	MAX T	AX.MIDTH	C1	C2
0	4.7000	0.0	0.3517E-04	0.2043	0.4987	0.1695	0.1303
10	4.7830	0.0	0.3529E-04	0.2091	0.4947	0.1690	0.1219
20	4.8660	0.0	0.3561E-04	0.2159	0.4907	0.1683	0.1149
30	4.9490	0.0	0.3607E-04	0.2241	0.4866	0.1672	0.1093
40	5.0320	0.0	0.3656E-04	0.2333	0.4826	0.1658	0.1049
50	5.1150	0.0	0.3699E-04	0.2430	0.4786	0.1649	0.1011
60	5.1980	0.0	0.3727E-04	0.2532	0.4745	0.1648	0.0976
70	5.2810	0.0	0.3753E-04	0.2638	0.4705	0.1645	0.0938
80	5.3640	0.0	0.3794E-04	0.2752	0.4666	0.1631	0.0892
90	5.4470	0.0	0.3834E-04	0.2879	0.4623	0.1599	0.0842
100	5.5300	0.0	0.3936E-04	0.3010	0.4583	0.1551	0.0787
ZS	RADIUS	C3	C4F	C4E	C4	ALPHA B	B
0	4.7000	0.1689	0.1926	0.3670	0.0634	58.63	0.5657
10	4.7830	0.1622	0.1883	0.3692	0.0766	58.11	0.5330
20	4.8660	0.1569	0.1851	0.3717	0.0796	57.46	0.5610
30	4.9490	0.1526	0.1835	0.3743	0.0819	56.70	0.5595
40	5.0320	0.1494	0.1834	0.3768	0.0859	55.83	0.5589
50	5.1150	0.1473	0.1840	0.3788	0.0920	54.82	0.5599
60	5.1980	0.1462	0.1848	0.3802	0.1007	53.67	0.5628
70	5.2810	0.1450	0.1866	0.3813	0.1104	52.39	0.5676
80	5.3640	0.1426	0.1904	0.3823	0.1016	51.00	0.5744
90	5.4470	0.1382	0.1966	0.3834	0.1253	49.50	0.5833
100	5.5300	0.1326	0.2053	0.3844	0.1293	47.92	0.5945

SATE EOX TURBINE 3RD BLADE

STRESS VS. SPAN AT 100% POWER

MAP = 64.0  
RPM = 25000  
PULL = 7248  
DENS = 0.3200

1 S-2 8/A SHROUD  
2 S-2 8/A F-311 SHROUD  
3 S-10 8/A - S-18 8MM19  
4 S-10 8/A - S-18 8MM19  
5 S-16 8/A - S-18 8MM19 S-18 8MM19

CONDITION:

SATE EOX TURBINE 3RD  
BLADE

STRESS AT 100% F

% SPAN BASED ON  
WEIGHT RADI  
R(1D) = 4.7300  
R(OD) = 5.5300

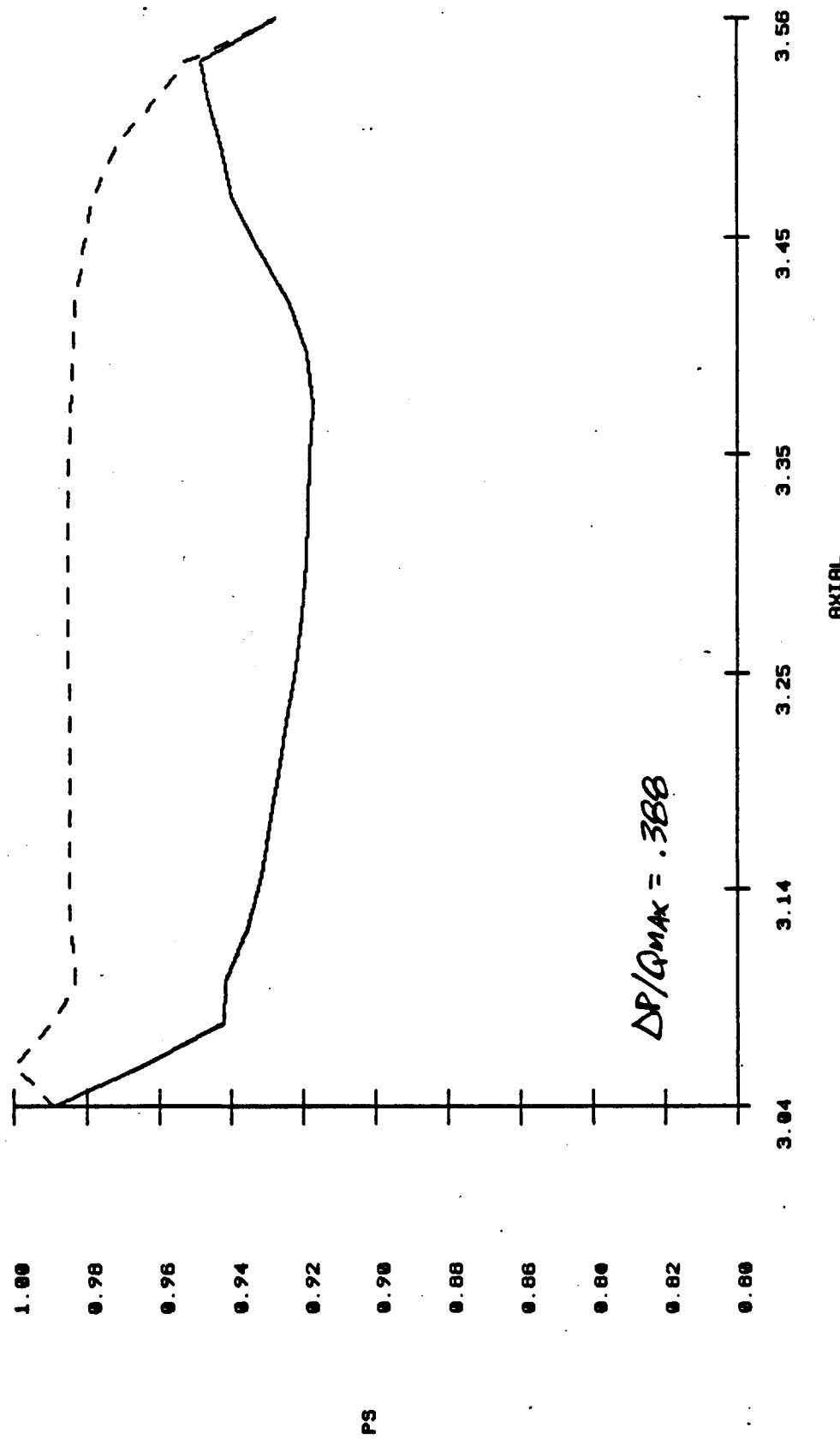
STRESS  
(ksi)

0 10 20 30 40 50 60 70 80 90 100

35

DF117464

ATD Oxidizer Pump Turbine  
3rd Blade Root  
3D Pressure Distribution



CURVE    ITER    I    J    K

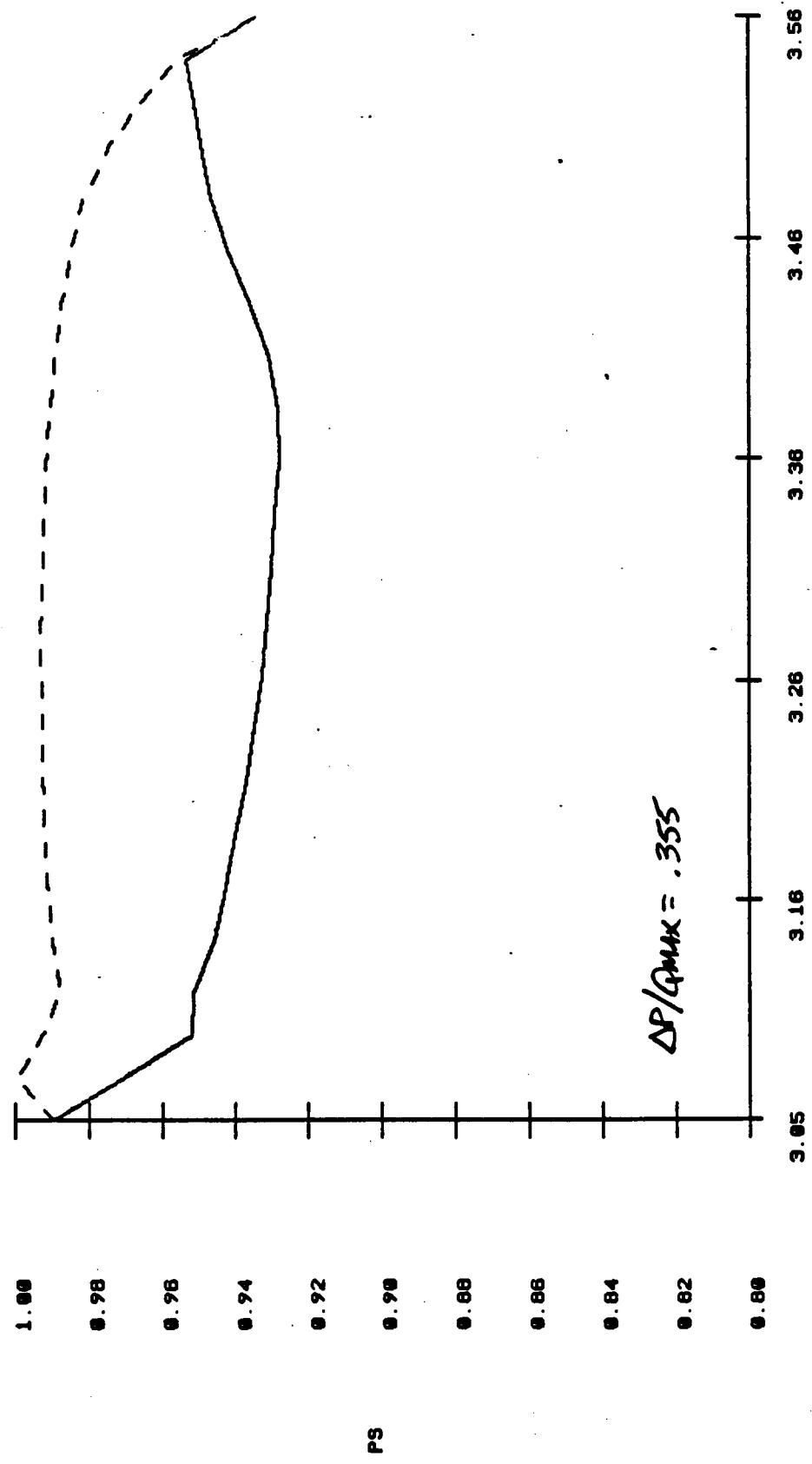
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1	0	1	0	1
2	0	9	0	1

AXIAL

1. PRINT RESULTS
  2. CALCOMP PLOT
  3. REDEFINE X RANGE
  4. REDEFINE Y RANGE
  5. NONDIMENSIONALIZE
  6. CONTINUE
- ENTER -
- DF117466-A

ATD Oxidizer Pump Turbine  
3rd Blade 1/4 Root  
3D Pressure Distribution



CURVE    ITER    I    J    K

---

1	0	1	0	3
2	0	9	0	3

RANGE = 6 10 28

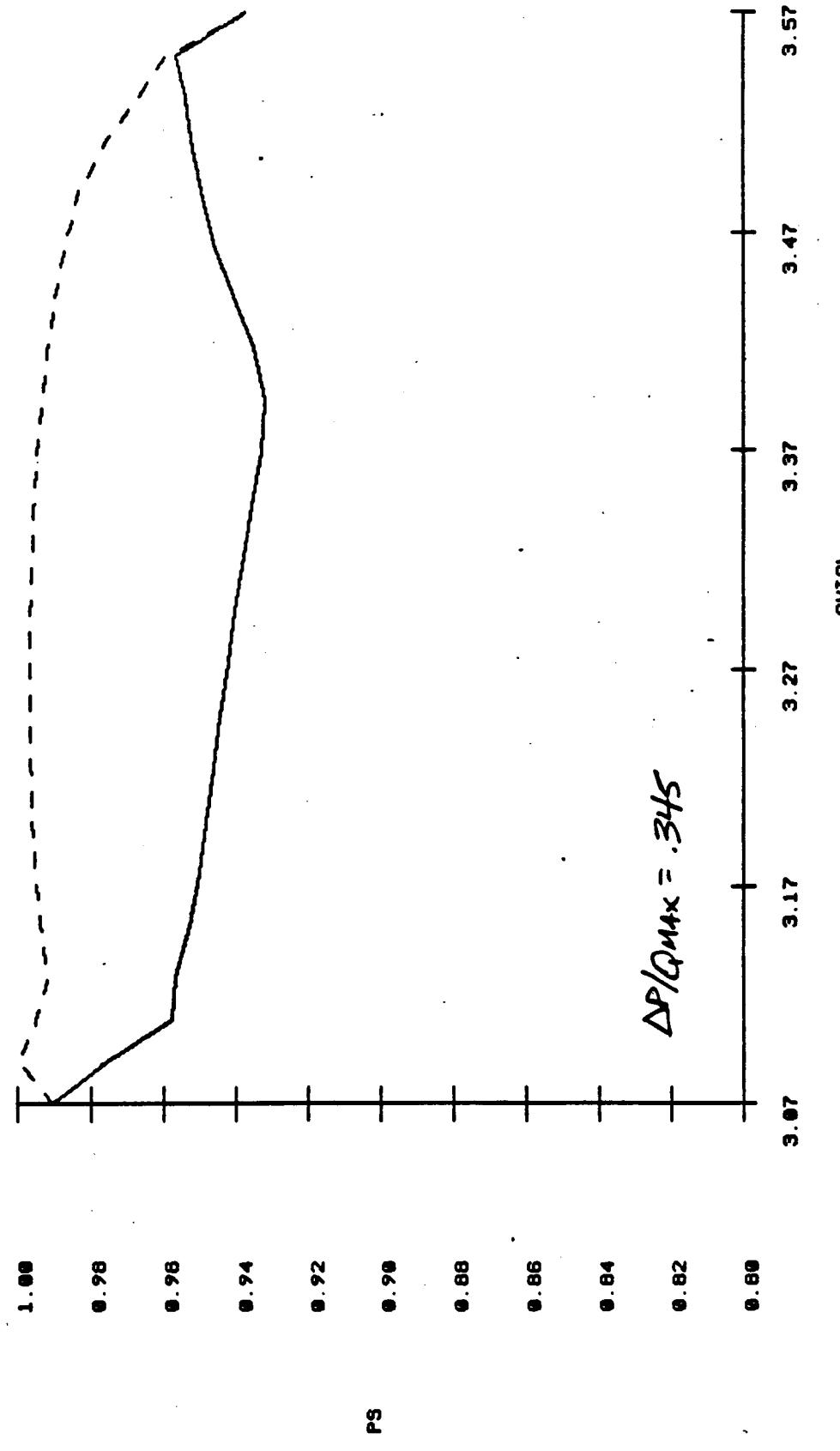
AXIAL

1. PRINT RESULTS
2. CALCOMP PLOT
3. REDEFINE X RANGE
4. REDEFINE Y RANGE
5. NONDIMENSIONALIZE
6. CONTINUE

ENTER -

DF117466-B

ATD Oxidizer Pump Turbine  
3rd Blade Mean  
3D Pressure Distribution



CURVE ITER I J K

---

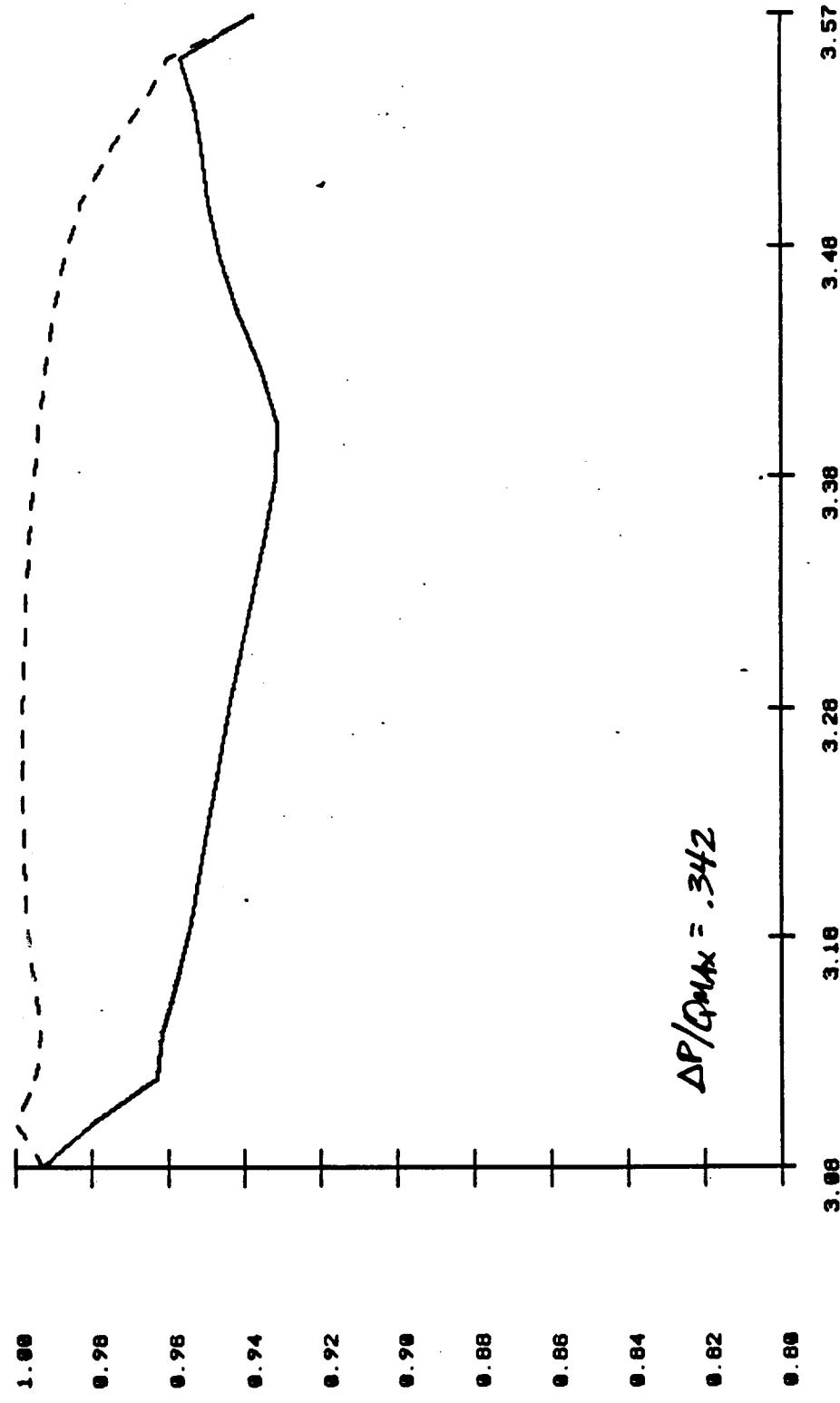
—	1	•	1	0	5
- - -	2	•	9	0	5

RANGE = 8 10 28

AXIAL

1. PRINT RESULTS
  2. CALCOMP PLOT
  3. REDEFINE X RANGE
  4. REDEFINE Y RANGE
  5. NONDIMENSIONALIZE
  6. CONTINUE
- ENTER -

ATD Oxidizer Pump Turbine  
3rd Blade 1/4 Tip  
3D Pressure Distribution



CURVE ITER I J K

---

1	0	1	0	7
2	0	9	0	7

RANGE = 6 TO 28

44

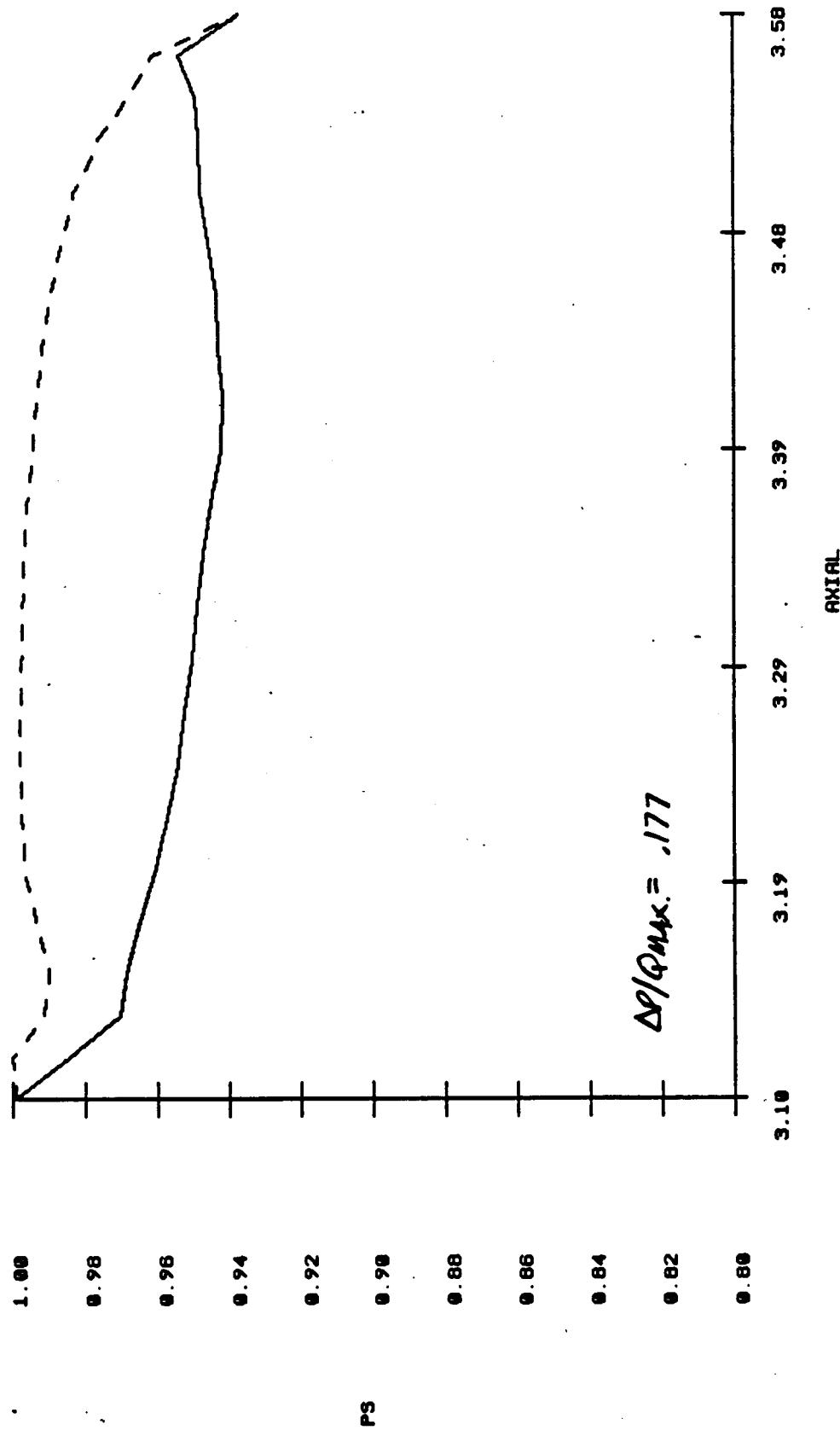
AXIAL

- 1. PRINT RESULTS
- 2. CALCOMP PLOT
- 3. REDEFINE X RANGE
- 4. REDEFINE Y RANGE
- 5. NODIMENSIONALIZE
- 6. CONTINUE

ENTER -

DF117466-D

ATD Oxidizer Pump Turbine  
3rd Blade Tip  
3D Pressure Distribution



CURVE ITER I J K

---

— 1 0 1 0 9

- - - 2 0 9 0 9

RANGE = 6 TO 26

1. PRINT RESULTS
2. CALCOMP PLOT
3. REDEFINE X RANGE
4. REDEFINE Y RANGE
5. NONDIMENSIONALIZE
6. CONTINUE

ENTER - DF117466-E



## U456 - FINITE TRANSITION INTEGRAL BOUNDARY LAYER DECK

DATE 9-8-13-87

TIME 14:43:46

PROFESSOR J. R. J. ROMEY 3BK3 3883.86 300 BLADE 14 FOOT

REF. 4.90 RTF = 4.91

4.007 TUR

INLET EXIT

MACH NO. 0.156 0.251

GAS ANGLES 34.06 18.37

SUCTION SIDE

REF. REYNOLDS NO. 5167408

0.0100

0.0090

0.0080

0.0070

0.0060

0.0050

0.0040

0.0030

0.0020

0.0010

0.0000

EFFECT COEF.

0.0 0.3 0.5 0.8 1.0

S DISTANCE (INCHES)

TRANSITION CHART

0.0

0.3

0.5

0.8

1.0

S DISTANCE (INCHES)

DF117465-B

## U458 - FINITE TRANSITION: INTEGRAL BOUNDARY LAYER DECK

DATE 08/12/97

TIME 14:20:27

RUROKID 1960 - T. L. REYNOLDS 3BK5 3874.81 - 30° BLADE MEAN

REFL 5.00 RTE = 5.12

4.001 IN. INLET EXIT

MACH NO. 0.138 0.249

GAS ANGLES 32.29 19.68

## SUCTION SIDE

REF. REYNOLDS NO. 5249056

0.0100

0.0090

0.0080

0.0070

0.0060

0.0050

0.0040

0.0030

0.0020

0.0010

0.0000

Y POSITION

0.0 0.3 0.5 0.8 1.0

S DISTANCE (INCHES)

## TRANSITION CHART

0.0 0.3 0.5 0.8 1.0

S DISTANCE (INCHES)

DF117465-C

## U456 - FINITE TRANSITION INTEGRAL BOUNDARY LAYER DECK

DATE 08/12/87

TIME 14:53:11

PROXID U7500

RENEY 3BK7 3890.61 30° BLADE #170

THERM

PRT#

5.33

4.00% TUR

INLET

EXIT

MACH NO.

0.124

0.249

GAS ANGLES 35.91

19.77

SUCTION SIDE

REF. REYNOLDS NO.

5452087

0.0100

0.0090

0.0080

0.0070

0.0060

0.0050

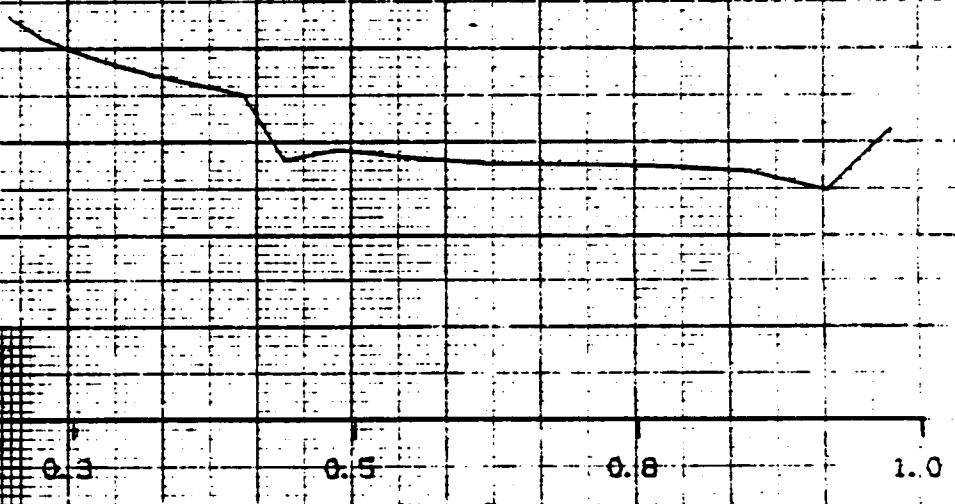
0.0040

0.0030

0.0020

0.0010

0.0000



S DISTANCE (INCHES)

TRANSITION CHART

0.0

0.2

0.5

0.8

1.0

S DISTANCE (INCHES)

DF117465-D

## U456 - FINITE TRANSITION INTEGRAL BOUNDARY LAYER DECK

DATE 08/13/87

TIME 14:59:11

RJROXID U760 R. J. ROMNEY 3BK9 3903.74 340 BLADE TIP

RTF= 5.19 RTF= 5.54

4.00% TEL

INLET

EXIT

MACH NO. 0.117 0.248

GAS ANGLES 47.00 25.51

REF. REYNOLDS NO. 5616138.

SUCTION SIDE

0.0100

0.0090

0.0080

0.0070

0.0060

0.0050

0.0040

0.0030

0.0020

0.0010

0.0000

FRICTION COEF.

0.0 0.3 0.5 0.8 1.0

S DISTANCE (INCHES)

TRANSITION CHART

0.0 0.3 0.5 0.8 1.0  
S DISTANCE (INCHES) DF117465-E